The Department of Defense

19941221 086

DoD DEPARTMENTS/AGENCIES:

Department of the Army

Department of the Navy

Department of the Air Force

ARPA Advanced Research Projects Agency

Special Operations Command

PROGRAM SOLICITATION 94.2
CLOSING DATE: 15 JULY 1994

FY 1994 SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROGRAM SOLICITATION

Number 94.2

Small Business Innovation Research Program

> **IMPORTANT**
>
> The DoD is updating its SBIR Mailing list. To remain on the mailing list or to be added to the list, send in the Mailing List form (Reference E), found at the back of this solicitation, to DTIC. Failure to send the form will result in no future mailings of the DoD SBIR Program Solicitation to your address.

U.S. Department of Defense
SBIR Program Office
Washington, DC 20301

Closing Date: JULY 15, 1994

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time.

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DoD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Army, Navy, Air Force, Advanced Research Projects Agency, and U.S. Special Operations Command hereafter referred to as DoD Components, invite small business firms to submit proposals under this program solicitation entitled Small Business Innovation Research (SBIR). Firms with strong research and development capabilities in science or engineering in any of the topic areas described in Section 8.0 are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research or research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research or research and development results.

The Federal SBIR Program is mandated by Public Laws PL 97-219, PL 99-443, and PL 102-564. The basic design of the DoD SBIR Program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive, January 1993. The DoD Program presented in this solicitation strives to encourage scientific and technical innovation in areas specifically identified by DoD Components. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, PL 97-219, PL 99-443, and PL 102-564. Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other applications. If it appears to have such potential, proposers are encouraged, on an optional basis, to obtain a contingent commitment for private follow-on funding to pursue further development of the commercial potential after the government funded research and development phases.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research or research and development effort and is expected to produce a well-defined deliverable product or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the small business is expected to use non-federal capital to pursue private sector applications of the research or development. Also, under Phase III, federal agencies may award non-SBIR funded follow-on contracts for products or processes which meet the mission needs of those agencies. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The federal research and development can serve as both a technical and pre-venture capital base for ideas which may have commercial potential.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in Section 8.0 hereof.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts will be considered (Section 4.3 and 5.2).

DoD is not obligated to make any awards under either Phase I, II, or III. DoD is not responsible for any monies expended by the proposer before award of any contract.

1.3 Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research or research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase II where it is felt that the research or research and development has commercial potential in the private sector.

Proposers who feel that their research or research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported research or development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. *Note that when several Phase II proposals receive evaluations being of approximately equal merit, proposals that demonstrate such a commitment for follow-on funding will receive extra consideration during the evaluation process.*

The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies as stated in Section 5.7.

1.4 Eligibility and Limitation

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the Cover Sheet (Appendix A) of the proposal. In addition, a minimum of two-thirds of each Phase I SBIR project must be carried out by the proposing firm. For Phase II, a minimum of one-half of the effort must be performed by the proposing firm. For both Phase I and II, the primary employment of the principal investigator must be with the small business firm at the time of the award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Deviations from these requirements must be approved in writing by the contracting officer (during contract negotiations).

For both Phase I and Phase II, the research or research and development work must be performed by the small business concern in the United States. "United States" means the fifty states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided that the entity created qualifies as a small business in accordance with the Small Business Act, 15 USC 631, and the definition included in Section 2.2.

1.5 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of 18 USC and 10 USC 2397. Such proposers should contact the cognizant Ethics Counsellor of the DoD Component for further guidance.

1.6 Contact with DoD

a. General Information. General information questions pertaining to proposal instructions contained in this solicitation should be directed to:

Mr. Bob Wrenn
SBIR Coordinator
OSD/SADBU
U.S. Department of Defense
The Pentagon - Room 2A340
Washington, DC 20301-3061
(703) 697-1481

Other non-technical questions pertaining to a specific DoD Component should be directed in accordance with instructions given at the beginning of that DoD Component's topics in Section 8.0 of this solicitation. Oral communications with DoD Components regarding the technical content of this solicitation during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness.

b. Requests for Copies of DoD SBIR Solicitation. To remain on the DoD SBIR Mailing list, send in the Mailing List form (Reference E) to DTIC. Additional copies of this solicitation may be ordered from:

Defense Technical Information Center
Attn: DTIC/SBIR
Building 5, Cameron Station
Alexandria, Virginia 22304-6415
(800) 225-3842 toll free
(703) 274-6903 commercial

This solicitation is also available on floppy diskette (in Word Perfect) from DTIC for a nominal processing fee.

The DoD SBIR solicitation can be obtained electronically using Business Gold, the National Technology Transfer Center's bulletin board system. Connect via Internet by telneting to **iron.nttc.edu**, or by dialing (304) 243-2560 for high speed modems (9600+) or (304) 243-2561 for 1200-2400 baud modems and logging in as guest. For more information on the NTTC electronic bulletin board system contact:

National Technology Transfer Center
Wheeling Jesuit College
316 Washington Ave
Wheeling, WV 26003
(800) 678-6882

c. Outreach Program. The DoD holds three National SBIR Conferences a year and participates in many state-organized conferences for small business. We have a special outreach effort to socially and economically and disadvantaged firms and to small companies that are negatively affected by the Defense down-sizing.

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development

Basic Research - Scientific study and experimentation to provide fundamental knowledge required for the solution of problems.

Exploratory Development - A study, investigation or minor development effort directed toward specific problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions.

Advanced Development - Proof of design efforts directed toward projects that have moved into the development of hardware for test.

Engineering Development - Full-scale engineering development projects for DoD use but which have not yet received approval for production.

2.2 Small Business

A small business concern is one that, at the time of award of a Phase I or Phase II contract:

a. Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;

b. Is at least 51% owned, or in the case of a publicly owned business, at least 51% of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;

c. Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 USC 661, et seq., are affiliates of one another when either directly or indirectly (1) one concern controls or has the power to control the other; or (2) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR 121.3-2(a). The term "number of employees" is defined in 13 CFR 121.3-2(t). Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Socially and Economically Disadvantaged Small Business

A small business that is at the time of award of a Phase I or Phase II contract:

a. At least 51% owned by an Indian tribe or a native Hawaiian organization, or one or more socially and economically disadvantaged individuals, and

b. Whose management and daily business operations are controlled by one or more socially and economically disadvantaged individuals.

A socially and economically disadvantaged individual is defined as a member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent-Asian Americans, or other groups designated by SBA to be socially disadvantaged.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51% owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management.

2.5 Funding Agreement

Any contract, grant, or cooperative agreement entered into between any federal agency and any small business concern for the performance of experimental, developmental, or research work funded in whole or in part by the federal government. *Only the contract method will be used by DoD components for all SBIR awards.*

2.6 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government contract awardee calling for supplies or services required solely for the performance of the original contract. This includes consultants.

2.7 Commercialization

The process of developing markets and producing and delivering products for sale (whether by the originating party or by others); as used here, commercialization includes both government and private sector markets.

3.0 PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

A proposal to any DoD Component under the SBIR Program is to provide sufficient information to persuade the DoD Component that the proposed work represents an innovative approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the chosen topic. Any small business contemplating a bid for work on any specific topic should determine that (a) the technical approach has a reasonable chance of meeting the topic objective, (b) this approach is innovative, not routine, and (c) the firm has the capability to implement the technical approach, i.e. has or can obtain people and equipment suitable to the task.

Those responding to this solicitation should note the proposal preparation tips listed below:

- Read and follow all instructions contained in this solicitation.
- Use the free technical information services from DTIC and other information assistance organizations (Section 7.1 - 7.4).
- Mark proprietary information as instructed in Section 5.5.
- Limit your proposal to 25 pages (excluding company commercialization report).
- Use a type size no smaller than 12 pitch or 11 point.
- Don't include proprietary or classified information in the project summary (Appendix B).
- Include a Red Copy of Appendix A and Appendix B as part of the Original of each proposal.
- Do not use a proportionally spaced font on Appendix A and Appendix B.
- Include a company commercialization report listing all SBIR Phase I and Phase II projects and the commercialization status of Phase II projects (see Section 3.4.n).

3.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary, commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 5.5.

3.3 Limitations on Length of Proposal

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of no more than 25 pages, excluding commercialization record summary, (no type smaller than 11 point or 12 pitch on standard 8½" X 11" paper with one (1) inch margins, 6 lines per inch), *including Proposal Cover Sheet (Appendix A), Project Summary (Appendix B), Cost Proposal (Appendix C), and any enclosures or attachments.* Promotional and non-project related discussion is discouraged. Cover all items listed below in Section 3.4 in the order given. The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, proposals in excess of the 25-page limitation (including attachments, appendices, or references, but excluding commercialization record summary) <u>will not</u> be considered for review or award.

3.4 Phase I Proposal Format

All pages shall be consecutively numbered and the ORIGINAL of each proposal must contain a completed red copy of Appendix A and Appendix B.

a. Cover Sheet. Complete <u>RED COPY</u> of Appendix A, photocopy the completed form, and use a copy as Page 1 of each additional copy of your proposal.

b. Project Summary. Complete <u>RED COPY</u> of Appendix B, photocopy the completed form, and use a copy as Page 2 of each additional copy of your proposal.

The technical abstract should include a brief description of the project objectives and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project Summary of successful proposals will be submitted for publication with unlimited distribution and, therefore, will not contain proprietary or classified information.

c. Identification and Significance of the Problem or Opportunity. Define the specific technical problem or opportunity addressed and its importance. (Begin on Page 3 of your proposal.)

d. Phase I Technical Objectives. Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. Phase I Work Plan. Provide an explicit, detailed description of the Phase I approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be delivered. Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

f. Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, the proposing firm, consultants, or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic.

Describe previous work not directly related to the proposed effort but similar. Provide the following: (1) short description, (2) client for which work was performed (including individual to be contacted and phone number), and (3) date of completion.

g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.
(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Potential Post Applications. Describe:

(1) Whether and by what means the proposed project appears to have potential use by the Federal Government.
(2) Whether and by what means the proposed project appears to have potential private sector application.

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this section. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name) and local governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

k. Consultants. Involvement of university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail and identified in Appendix C. A minimum of <u>two-thirds</u> of each Phase I SBIR project must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current, or Pending Support. If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been funded, is now being funded, or is pending with another federal agency or DoD Component or the same DoD Component, the proposer must indicate action on Appendix A and provide the following information:

(1) Name and address of the federal agency(s) or DoD Component to which a proposal was submitted, will be submitted, or from which an award is expected or has been received.
(2) Date of proposal submission or date of award.
(3) Title of proposal.
(4) Name and title of principal investigator for each proposal submitted or award received.
(5) Title, number, and date of solicitation(s) under which the proposal was submitted, will be submitted, or under which award is expected or has been received.
(6) If award was received, state contract number.
(7) Specify the applicable topics for each SBIR proposal submitted or award received.

Note: If Section 3.4.1 does not apply, state in the proposal "No prior, current, or pending support for proposed work."

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow the DoD Component to understand how the proposer plans to use the requested funds if the contract is awarded.

(1) List all key personnel by name as well as by number of hours dedicated to the project as direct labor.
(2) Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the government or acquired with government funds will be vested with the DoD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.
(3) Cost for travel funds must be justified and related to the needs of the project.
(4) Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a proposal.

n. Company Commercialization Report of Prior SBIR Awards. For Phase I proposals, if the small business concern has received more than 15 Phase II awards in the prior 5 fiscal years, it must submit a Company Commercialization Report that lists the name of awarding agency, date of award, contract number, topic or subtopic, title, and award amount for each Phase I and Phase II project, and commercialization status for each Phase II. All Phase II proposals must include a Company Commercialization Report. (This required proposal information shall not be counted toward proposal pages count limitations.)

3.5 Bindings

Do not use special bindings or cover. Staple the pages in the upper left hand corner of each proposal.

3.6 Phase II Proposal

This solicitation is for Phase I only. A Phase II proposal can be submitted only by a Phase I awardee and only in response to a request from the agency; that is, Phase II is not initiated by a solicitation. Each proposal must contain a Red Cover Sheet (Appendix A), a Red Project Summary Sheet (Appendix B), and a Company Commercialization Report (see Section 3.4.n) regardless of the number of Phase II awards received. Copies of Appendices along with instructions regarding Phase II proposal preparation and submission will be provided by the DoD Components to all Phase I winners at time of Phase I contract award.

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless offeror states otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the chosen topic. Those found to be relevant will then be evaluated using the criteria listed in Section 4.2. Final decisions will be made by the DoD Component based upon these criteria and consideration of other factors including possible duplication of other work, and program balance. A DoD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DoD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a Government Contracting Officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will be conducted between the offeror and the Government Contracting Officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to a technical review process similar to Phase I. Final decisions will be made by DoD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research or research and development, program balance, budget limitations, and the potential of a successful Phase II effort leading to a product of continuing interest to DoD.

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors on their proposals.

4.2 Evaluation Criteria - Phase I

The DoD Components plan to select for award those proposals offering the best value to the government and the nation considering the following factors.

- **a.** The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution
- **b.** The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization
- **c.** The adequacy of the proposed effort for the fulfillment of requirements of the research topic
- **d.** The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referenced experiments. Relevant supporting data such as journal articles, literature, including government publications, etc., should be contained or referenced in the proposal.

4.3 Evaluation Criteria - Phase II

The Phase II proposal will be reviewed for overall merit based upon the criteria below.

- **a.** The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution
- **b.** The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization
- **c.** The adequacy of the proposed effort for the fulfillment of requirements of the research topic
- **d.** The qualifications of the proposed principal/key investigators supporting staff and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the government. Where technical evaluations are essentially equal in merit, cost to the government will be considered in determining the successful offeror.

The follow-on funding commitment must provide that a specific amount of Phase III funds will be made available to or by the small business and indicate the dates the funds will be made available. It must also contain specific technical objectives which, if achieved in Phase II, will make the commitment exercisable by the small business. The terms cannot be contingent upon the obtaining of a patent due to the length of time this process requires. The funding commitment shall be submitted with the Phase II proposal.

Phase II proposal evaluation may include on-site evaluations of the Phase I effort by government personnel.

4.4 Assessing Commercial Potential of Proposals

A Phase I or Phase II proposal's commercial potential can be evidenced by:

(1) the small business concern's record of commercializing SBIR or other research (see Company Commercialization Report, Section 3.4.n),
(2) the existence of second phase funding commitments from private sector or non-SBIR funding sources,
(3) the existence of third phase follow-on commitments for the subject of the research, or
(4) the presence of other indicators of commercial potential of the idea.

5.0 CONTRACTUAL CONSIDERATIONS

Note: Eligibility and Limitation Requirements (Section 1.4) Will Be Enforced

5.1 Awards (Phase I)

a. Number of Phase I Awards. The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim Phase I modifications, and the number of anticipated Phase II contracts. No Phase I contracts will be awarded until all qualified proposals (received in accordance with Section 6.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than January 15, 1995. The name of those firms selected for awards will be announced. *The DoD Components anticipate making 300 Phase I awards from this solicitation.*

b. Type of Funding Agreement. All winning proposals will be funded under negotiated contracts and may include a fee or profit. The firm fixed price or cost plus fixed fee type contract will be used for all Phase I projects (see Section 5.4). *Note: The firm fixed price contract is the preferred type for Phase I.*

c. Average Dollar Value of Awards. DoD Components will make Phase I awards to small businesses typically on a one-half person-year effort over a period generally not to exceed six months (subject to negotiation). PL 102-564 allows agencies to award Phase I contracts up to $100,000 without justification. <u>Where applicable, specific funding instructions are contained in Section 8 for each DoD Component.</u>

5.2 Awards (Phase II)

a. Number of Phase II Awards. The number of Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. *The DoD Components anticipate that approximately 40 percent of its Phase I awards will result in Phase II projects.*

b. Type of Funding Agreement. Each Phase II proposal selected for award will be funded under a negotiated contract and may include a fee or profit.

c. Project Continuity. Phase II proposers who wish to maintain project continuity must submit proposals no later than 30 days prior to the expiration date of the Phase I contract and must identify in their proposal the work to be performed for the first four months of the Phase II effort and the costs associated therewith. *These Phase II proposers may be issued a modification to the Phase I contract, <u>at the discretion of the government</u>,* covering an interim period not to exceed four months for preliminary Phase II work while the total Phase II proposal is being evaluated and a contract is negotiated. This modification would normally become effective at the completion of Phase I or as soon thereafter as possible. Funding, scope of work, and length of performance for this interim period will be subject to negotiations. Issuance of a contract modification for the interim period does not commit the government to award a Phase II contract. <u>See special instructions for each DoD Component in Section 8.</u>

d. Average Dollar Value of Awards. Phase II awards will be made to small businesses based on results of the Phase I efforts and the scientific, technical, and commercial merit of the Phase II proposal. Average Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). PL 102-564 states that the Phase II awards may be up to $750,000 each without justification. <u>See special instructions for each DoD Component in Section 8.</u>

5.3 Reports

a. Content. A final report is required for each Phase I project. The report must contain in detail the project objectives, work performed, results obtained, and estimates of technical feasibility. A completed SF 298, "Report Documentation Page", will be used as the first page of the report. In addition, Monthly status and progress reports may be required by the DoD agency. (A Sample SF 298 is provided in Reference D.)

b. Preparation.

(1) To avoid duplication of effort, language used to report Phase I progress in a Phase II proposal, if submitted, may be used verbatim in the final report with changes to accommodate results after Phase II proposal submission and modifications required to integrate the final report into a self-contained comprehensive and logically structured document.

(2) Block 12a (Distribution/Availability Statement) of the SF298, "Report Documentation Page" in each unclassified final report must contain one of the following statements:
   - (a) Distribution authorized to U.S. Government Agencies only; report contains proprietary data produced under SBIR contract. Other requests shall be referred to the performing organization in Block 7 of this form.
   - (b) Approved for public release; SBIR report, distribution unlimited.

(3) The report abstract (Block 13 of the SF 298, "Report Documentation Page") must identify the purpose of the work and briefly describe the work carried out, the finding or results and the potential applications of the effort. Since the abstract may be published by the DoD, it must not contain any proprietary or classified data.

c. Submission. <u>SIX COPIES</u> of the final report on each Phase I project shall be submitted within the DoD in accordance with the negotiated delivery schedule. Delivery will normally be within thirty days after completion of the Phase I technical effort. One copy of each unclassified report shall be delivered directly to the DTIC, ATTN: Document Acquisition, Cameron Station, Alexandria, VA 22304-6145.

5.4 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon completion of negotiations between the DoD and the successful Phase I or Phase II offeror. Successful offerors may be paid periodically as work progresses in accordance with the negotiated price and payment schedule. Phase I contracts are primarily fixed price contracts, under which monthly progress payments may be made up to 90% of the contract price excluding fee or profit. The contract may include a separate provision for payment of a fee or profit. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Other types of financial assistance may be available under the contract.

5.5 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data which the proposer does not want disclosed to the public or used by the government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer except for Appendices A and B. The government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "confidential proprietary information" and provided that the following legend which appears on the title page (Appendix A) of the proposal is completed:

> "For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to the proposer as a result of or in connection with the submission of this data, the government shall have the right to duplicate, use or disclose the data to the extent provided in the contract. This restriction does not limit the government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s)________of this proposal."

Any other legend may be unacceptable to the government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

> "Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

The government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information will be requested to expeditiously submit to the DoD Component a detailed listing of all information in the proposal which the proposer believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DoD Component pursuant to the Act is properly determined.

Those proposers that have a classified facility clearance may submit classified material with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M) procedures for marking and handling classified material.

5.6 Copyrights

To the extent permitted by statute, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DoD support. DoD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgement and disclaimer statement.

5.7 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with government support. The government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the government will not make public any information disclosing a government-supported invention for a reasonable time period to allow the awardee to pursue a patent.

5.8 Technical Data Rights

Rights in technical data, including software, developed under the terms of any contract resulting from proposals submitted in response to this solicitation shall remain with the contractor, except that the government shall have the limited right to use such data for government purposes and shall not release such data outside the government without permission of the contractor for a period of four years from completion of the project from which the data was generated unless the data has already been released to the general public. However, effective at the conclusion of the four-year period, the government shall retain a royalty-free license for government use of any technical data delivered under an SBIR contract whether patented or not. See FAR clause 52.227-20, "Rights in Data - SBIR Program" and DFARS 252-227-7013 alternate II(3) "Government Purpose Licence Rights".

5.9 Cost Sharing

Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of any Phase I proposal.

5.10 Joint Ventures or Limited Partnerships

Joint ventures and limited partnerships are eligible provided the entity created qualifies as a small business as defined in Section 2.2 of this solicitation.

5.11 Research and Analytical Work

a. For Phase I a minimum of two-thirds of the research and/or analytical effort must be performed by the proposing firm unless otherwise approved in writing by the contracting officer.

b. For Phase II a minimum of one-half of the research and/or analytical effort must be performed by the proposing firm, unless otherwise approved in writing by the contracting officer.

5.12 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. Standards of Work. Work performed under the contract must conform to high professional standards.

b. Inspection. Work performed under the contract is subject to government inspection and evaluation at all reasonable times.

c. Examination of Records. The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. Default. The government may terminate the contract if the contractor fails to perform the work contracted.

e. Termination for Convenience. The contract may be terminated at any time by the government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. Disputes. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. Contract Work Hours. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).

h. Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. Affirmative Action for Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. Officials Not to Benefit. No member of or delegate to Congress shall benefit from the contract.

l. Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bona fide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. Gratuities. The contract may be terminated by the government if any gratuities have been offered to any representative of the government to secure the contract.

n. Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. Military Security Requirements. The contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

p. American Made Equipment and Products. When purchasing equipment or a product under the SBIR funding agreement, purchase only American-made items whenever possible.

5.13 Additional Information

a. General. This Program Solicitation is intended for information purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

b. Small Business Data. Before award of an SBIR contract, the government may request the proposer to submit certain organizational, management, personnel, and financial information to confirm responsibility of the proposer.

c. Proposal Preparation Costs. The government is not responsible for any monies expended by the proposer before award of any contract.

d. Government Obligations. This Program Solicitation is not an offer by the government and does not obligate the government to make any specific number of awards. Also, awards under this program are contingent upon the availability of funds.

e. Unsolicited Proposals. The SBIR Program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals will not be accepted under the SBIR Program in either Phase I or Phase II.

f. Duplication of Work. If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

g. Classified Proposals. If classified work is proposed or classified information is involved, the offeror to the solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M).

6.0 SUBMISSION OF PROPOSALS

An original plus (4) copies of each proposal or modification will be submitted, in a single package, as described below, unless otherwise stated by specific instructions in Section 8.0.

NOTE: THE ORIGINAL OF EACH PROPOSAL MUST CONTAIN A COMPLETED RED COPY OF APPENDIX A (COVER SHEET) AND APPENDIX B (PROJECT SUMMARY), AND A COMPANY COMMERCIALIZATION REPORT (see Section 3.4.n).

6.1 Address

Each proposal or modification package must be addressed to that DoD Component address which is identified for the specific topic in that Component's section of Section 8.0 to this solicitation.

The name and address of the offeror, the solicitation number and the topic number for the proposal must be clearly marked on the face of the envelope or wrapper.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secured packaging is mandatory. The DoD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal must be sent in the same package. Do not send separate information copies or several packages containing parts of the single proposal.

6.2 Deadline of Proposals

Deadline for receipt of proposals at the DoD Component is 2:00 p.m. local time, July 15, 1994. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and: (a) it was sent by registered or certified mail not later than July 8, 1994 or (b) it was sent by mail and it is determined by the government that the late receipt was due solely to mishandling by the government after receipt at the government installation.

Note: There are no other provisions for late receipt of proposals under this solicitation.

The only acceptable evidence to establish (a) the date of mailing of a late-received proposal sent either by registered mail or certified mail is the U. S. Postal Service postmark on the wrapper or on the original receipt from the

U. S. Postal Service. If neither postmark shows a legible date, the proposal shall be deemed to have been mailed late. The term postmark means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed on the date of mailing by employees of the U. S. Postal Service. Therefore, offerors should request the postal clerk to place a hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper; (b) the time of receipt at the government installation is the time-date stamp of such installation on the proposal wrapper or other documentary evidence of receipt maintained by the installation.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal. (NOTE: the term telegram includes mailgrams.)

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages (excluding company commercialization record). Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the government will be considered at any time it is received and may be accepted.

6.3 Notification of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self-addressed stamped envelope and a copy of the notification form (Reference A) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 6.2.

6.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

6.5 Debriefing of Unsuccessful Offerors

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors for their proposals.

6.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number and specific topic number and should be addressed to the DoD Component whose address is associated with the specific topic number.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 DoD Technical Information Services Available

Recognizing that small businesses may not have strong technical information service support, the Defense Technical Information Center (DTIC) is prepared to give special attention to the needs of DoD SBIR Program participants.

DTIC, the central source of scientific and technical information resulting from and describing R&D projects funded by DoD, is a major component of the DoD Scientific and Technical Information Program. DTIC provides access to and transfer of scientific and technical information for DoD personnel, DoD contractors, and other federal agencies and their contractors. The information assistance provided by DTIC enables organizations preparing R&D proposals to DoD to make better-informed bid decisions and technically stronger submittals.

DTIC prepares a Technical Information Package (TIP) for most SBIR topics. TIPs contain a bibliographic listing of technical reports from DoD-funded work in technical areas related to the SBIR topic. TIPs may also include additional information provided by the topic author and references to other information sources.

Firms responding to this solicitation are encouraged to use Reference B at the back of this solicitation or telephone DTIC for background information covering their proposal topic areas. DTIC will return the material you request, annotated with a temporary user code for use when requesting additional information or when ordering technical reports cited in a bibliography. Reasonable quantities of technical reports from the DTIC collection are available at no cost to support SBIR proposal preparation.

Call, or visit (by prearrangement) DTIC at the following location which is most convenient to you. All written communications with DTIC must be made to the Alexandria, VA, address.

Defense Technical Information Center
ATTN: DTIC-User Services
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 225-3842
(703) 274-9274 (FAX)

DTIC Boston Regional Office
Building 1103, 5 Wright Street
Hanscom AFB
Bedford, MA 01731-5000
(617) 377-2413

DTIC Albuquerque Regional Office
PL/SUL
3550 Aberdeen Ave, SE
Kirtland AFB, NM 87117-6008
(505) 846-6797

DTIC Los Angeles Regional Office
222 N. Sepulveda Blvd., Suite 906
El Segundo, CA 90245-4320
(310) 335-4170

For information services in the areas of manpower, personnel, training and simulation devices, human factors and safety, contact the DTIC Manpower and Training Research Information System (MATRIS):

DTIC MATRIS Office
ATTN: DTIC-AM, Sally Ames
San Diego, CA 92152-6800
(619) 553-7008

DTIC also provides access to specialized reference services and subject matter expertise within the DoD-sponsored Centers for Analysis of Scientific and Technical Information (IACs). IACs are concerned with the Scientific and Technical Information content of worldwide engineering, technical and scientific documents and databases. They receive technical management and direction from the DoD organizations with leading competence in the science and technology area within which each IAC functions. For more information on how to utilize the DTIC IAC program and other DoD IACs contact:

Defense Technical Information Center
DTIC-IAC Program Manager
Alexandria, VA 22304-6145
(703) 274-6260
(703) 274-0980 (FAX)

7.2 Other Technical Information Assistance Sources

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

National Technical Information Services
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4600
(703) 321-8547 (FAX)

University of Southern California
Technology Transfer Center
3716 South Hope Street, Suite 200
Los Angeles, CA 90007-4344
(800) 872-7477 (outside CA)
(213) 743-6132
(213) 746-9043 (FAX)

Center for Technology Commercialization
Massachusetts Technology Park
100 North Drive
Westborough, MA 01581
(508) 870-0042
(508) 366-0101 (FAX)

Great Lakes Technology Transfer Center/Battelle
25000 Great Northern Corporate Center, Suite 260
Cleveland, OH 44070
(216) 734-0094
(216) 734-0686 (FAX)

Midcontinent Technology Transfer Center
Texas Engineering Experiment Station
The Texas A&M University System
237 Wisenbaker Engineering Research Center
College Station, TX 77843-3401
(409) 845-8762
(409) 845-3559 (FAX)

Mid-Atlantic Technology Applications Center
University of Pittsburgh
823 William Pitt Union
Pittsburgh, PA 15260
(800) 257-2725
(412) 648-7000
(412) 648-7003 (FAX)

Southern Technology Application Center
University of Florida, College of Engineering
Box 24, One Progress Boulevard
Alachua, FL 32615
(904) 462-3913
(800) 225-0308 (outside FL)
(904) 462-3898 (FAX)

Information Strategists
814 Elm Street
Manchester, NH 03104
(603) 624-8208

Federal Information Exchange, Inc.
555 Quince Orchard Road, Suite 200
Gaithersburg, MD 20878
(301) 975-0103
(301) 975-0109 (FAX)

7.3 DoD Counseling Assistance Available

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Management activities throughout the continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See Reference C at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to these activities.)

7.4 State Assistance Available

Many states have established programs to provide services to those small firms and individuals wishing to participate in the Federal SBIR Program. These services vary from state to state, but may include:

- Information and technical assistance;
- Matching funds to SBIR recipients;
- Assistance in obtaining Phase III funding.

Contact your State Government Office of Economic Development for further information.

8.0 TECHNICAL TOPICS

Section 8 contains detailed topic descriptions outlining the technical problems for which DoD Components requests proposals for innovative R&D solutions from small businesses. Topics for each participating DoD Component are listed and numbered separately. Each DoD Component Topic Section contains topic descriptions, addresses of organizations to which proposals are to be submitted, and special instructions for preparing and submitting proposals to organizations within the component. Read and follow these instructions carefully to help avoid administrative rejection of your proposal.

Appendices A, B and C follow the Component Topic Sections. Appendix A is a red-printed Proposal Cover Sheet, Appendix B is a red-printed Project Summary form, and Appendix C is an outline for the Cost Proposal. An original red-printed copy of Appendix A and Appendix B must be included with each proposal submitted.

U.S. Army 94.2
Submission of Proposals

Topics

The Army has identified 100 new topics for this solicitation, which address Critical Technologies especially relevant to be Army, the Army Science and Technology Master Plan, and the STAR 21 Strategic Technologies for the Army of the twenty-first century. An attempt has also been made to identify the commercial potential of these initiatives.

Dollar Caps

The maximum dollar amount from the SBIR budget for Army Phase I awards is $70,000. Additional program dollars may be added by the program activity. To reduce the funding gap between Phase I and Phase II, firms may submit an option task not to exceed $30,000 with the Phase I proposal. Exercise of such an option would be intended to allow Phase II preparatory work to be initiated; however, the option does not obligate the Army to make a Phase II award. Firms who are awarded the option should reflect the funds as a deduction on the total cost of their Phase II proposal. Future Army Phase IIs will average about $600,000. Those companies who have been invited to submit a Phase II proposal and have almost finished their Phase I work must submit a plan on how they will commercialize the technology with the government or with the private sector. This commercialization plan is required in addition to the descriptive technical portion of the proposal if they desire to compete for a Phase II. Cost sharing options in Phase II are encouraged and will be used as an evaluation factor for proposed Phase IIs over $600,000.

Army Science and Technology Areas

The Army topics have been grouped into the ten Army Technology Areas listed below. Descriptions of these areas are provided on the following pages.

A-1 Advanced Materials and Manufacturing (Structural & Energetic Materials)
A-2 Microelectronics and Photonics
A-3 Sensors and Information Processing (Communications)
A-4 High Performance Computing, Communications, Networking, and Simulation (Modeling Displays, AI, Virtual Reality)
A-5 Advanced Propulsion Technologies (Mobility and Lethality)
A-6 Power and Directed Energy
A-7 Biotechnology
A-8 Life, Medical and Behavioral Sciences
A-9 Environmental and Geosciences
A-10 Engineering Sciences (Robotics, Dynamics, Structures, Mechanics, and Construction)

Industry-Generated Future Topics

To enhance industry involvement in the Army SBIR process, I welcome suggestions from small firms for future Army topics. Kindly forward your topics to Mr. Joe Forry **after** this solicitation. Unsolicited proposals will not be accepted.

LTC John Peeler
Army SBIR Program Manager

Inquiries only (do not send proposals to the address below)

HQDA
OASA (RDA)
Pentagon, Room 3D318
Washington, D.C. 20310-0103

DESCRIPTIONS OF THE TEN TECHNOLOGY AREAS

AREA 1: Advanced Materials and Manufacturing

Advanced material technologies will significantly improve Army capabilities by providing lighter weight, stronger, and more durable materials that will improve the performance and efficiency of soldiers and their battlefield systems. Advanced materials and manufacturing incorporates the synthesis, processing, characterization, and predictive modeling of materials, as well as manufacturing technologies to reduce the time, risk, and cost of acquiring materials. Increasing demands on future battlefield systems will require tailor-made materials and structures with major performance improvements. In addition, requirements for cost reduction and reliability enhancement will continue to push the limits of manufacturing science and technology.

AREA 2: Microelectronics and Photonics

Microelectronics and photonics technologies underpin all Army systems for signal acquisition, communication, computation, and processing. As the heart of Army systems, these technologies establish how well battlefield devices (such as smart weapons, fire control systems, warning receivers, electronic warfare gear, and intelligence collection devices) will perform. Microelectronics includes such technologies as smart high-resolution displays and hybridized integrated circuits. Photonics uses light to represent, manipulate, and transmit information which includes such technologies as integrated optics and fiber optic technology.

AREA 3: Sensors and Information Processing

Sensors and information processing technologies have become the brains of modern weapon systems by providing quick and accurate information about troop positions, target locations, and battlefield conditions. Sensors and information processing include the application of sensors and signal processing for acquiring, developing, fusing, and disseminating information on target identification and location. Sensors should operate throughout the electromagnetic and acoustic spectrums. Sensor technology includes active, passive, imaging, non-imaging, line-of-sight (LOS) and non-line-of-sight. Information processing includes preparing and analyzing detector fronted signals, developing information and fusing information from multiband sensor networks, and forming communication links and communication networks where information is integrated and displayed.

AREA 4: High Performance Computing, Communications, Networking and Simulation

High performance computing, communication, networking and simulation are necessary to achieve an electronic battlefield where material and doctrine development, training, and research can be accomplished synergistically. It focuses on technology development to assure Army specific requirements are inserted into the Battlefield Distributed Simulation-Developmental (BDS-D) process and other simulation applications. This technology encompasses computing and communication, system representation and integration, physical environment representation, interface factors, and human characteristics and representation.

AREA 5: Advanced Propulsion Technologies

Advanced propulsion technology provides the muscle for Army land combat systems: aircraft, vehicles, guns, missiles, and soldiers. These systems coupled to modern doctrine, tactics, and training provide our soldiers the capabilities needed to dominate maneuver battles. Increased (propulsion system) power-to-weight and reduced fuel consumption lead to more compact, better performing, less vulnerable platforms. Improvements in range and lethality of guns and missiles depend on the availability of propulsion systems and survivable, energetic materials with very high rates of energy output. Advanced propulsion technologies include such technologies as ground vehicle transmissions/engines and ballistic propulsion.

AREA 6: Power and Directed Energy

Advanced technology development in power and directed energy will give the Army a distinct offensive and defensive advantage over adversaries. Critical areas for Army energetic power sources include a need for reduced cost, very high-energy density stealthy power sources for C3I missions, laser countermeasures devices, night vision devices, laser designator, smart munitions, tank silent watch, and future soldier systems. Man-portable systems requirements desiring very high-power and energy densities, including reductions in weight and volume, must be met with safe and low-cost power sources. The three principal divisions of requirements for Army technology in directed energy include lasers, High-Power Radio Frequency (HPRF), and particle beams.

AREA 7: Biotechnology

Biotechnology contributes to Army functions in many important ways from environmental remediation to improved soldier endurance and recovery. The Army uses biotechnology for medical and non-medical products and processes. The medical applications include disease prevention, defense against biological and chemical weapons, therapeutic interventions, diagnostics of infectious diseases, and sustainment of performance. The non-medical applications include chemical and biological (CB) defense, bioremediation, demilitarization, food technology, and materials design and manufacture.

AREA 8: Life, Medical, and Behavioral Sciences

Potential threats to soldier health and welfare have increased in deployments to a variety of worldwide geographical and climatic conditions. Army research needed in life, medical, and behavioral sciences address the development of technologies to protect, sustain, and restore the health of soldiers and units. Research requirements include food and nutrition technologies as well as medical technologies for improved vaccines, drugs, therapies, diagnostics for infectious diseases, chemical and biological defense, traumatic battle injuries and casualty care, combat dentistry, and treatment of soldier stress. Research in behavioral science and technology enhances soldier-system performance.

AREA 9: Environmental and Geosciences

Environmental and geosciences research encompasses the physical environment where the Army lives, trains, tests, and fights. Research also considers the effects of the environment on material, personnel, and tactics. Environment and geosciences technology includes environmental clean-up; identification of nuclear, biological, and chemical (NBC) hazard zones; and maintaining training and testing lands for continued safe use.

AREA 10: Engineering Sciences

Army disciplines for engineering sciences are principally focused in structural mechanics, fluid dynamics, control theory and control systems, and systems engineering and integration. Engineering sciences offer significant improvements in system efficiency, durability, performance enhancements, and cost savings throughout the Army's infrastructure. Research in engineering sciences includes design, modeling, and fatigue and failure analyses in structural mechanics; fluid dynamics methodologies; control theory and integration; experimental simulation; and systems engineering.

ARMY SMALL BUSINESS INNOVATION RESEARCH

Submitting Proposals on Army Topics

Phase I proposal (5 copies including 1 red-printed form) should be addressed to:

Commander
U.S. Army Materiel Command
ATTN: AMCRD-SBIR (Mr. Joe Forry)
5001 Eisenhower Avenue
Alexandria, VA 22333
(703) 617-7425

POINTS OF CONTACT SUMMARY

COMMAND	POC	TELEPHONE	TOPICS
ARDEC	J. Greenfield	(201) 724-6048	A94-001/A94-002, A94-026/A94-027, A94-057/A94-058, A94-085, A94-093/A94-095
ARI	M. Drillings	(703) 274-5572	A94-077
ARO	M. Brown	(919) 549-4336	A94-007, A94-021, A94-030, A94-074, A94-087/A94-089
AC&ISD	R. Dimmick	(410) 278-6955	A94-028/A94-029
BED	O. Johnson	(505) 678-3608	A94-086
E&PSD	R. Stern	(908) 544-4666	A94-017, A94-071
HR&ED	J. Sissum	(410) 278-5815	A94-076
MD	B. Morrissey	(617) 923-5522	A94-003/A94-004
S3I	S. Corbett	(301) 394-4603	A94-018
SLAD	O. Johnson	(505) 678-3608	A94-019
VPD	P. Meitner	(216) 433-3715	A94-067
VSD	J. Cline	(804) 864-3966	A94-005
WTD	R. Dimmick	(410) 278-6955	A94-006, A94-020, A94-096
AVRDEC	R. Warhover	(314) 263-1465	A94-008/A94-010, A94-059, A94-068, A94-097/A94-098
CECOM	J. Crisci	(908) 544-2665	A94-014/A94-015, A94-031/A94-046, A94-072
CERL	D. Moody	(217) 373-7205	A94-090
ERDEC	R. Hinkle	(410) 671-2031	A94-073
CRREL	A. Ayorinde	(603) 646-4289	A94-091
MEDICAL	A. Wolf	(301) 619-7216	A94-075, A94-078/A94-084
MICOM	O. Thomas, Jr.	(205) 842-9227	A94-022, A94-047/A94-049, A94-060/A94-061, A94-069, A94-099
NATICK	B. Rosenkrans	(508) 651-5296	A94-011/A94-013
SDC	E. Roy	(205) 955-4393	A94-053/A94-056
STRICOM	A. Piper	(407) 380-4287	A94-062/A94-063
TACOM	A. Sandel	(313) 574-7545	A94-016, A94-023/A94-025, A94-050, A94-064, A94-070
TECOM	R. Cozby	(410) 278-1481	A94-051, A94-065/A94-066, A94-100
TEC	J. Jamieson	(703) 355-2631	A94-052
WES	P. Stewart	(601) 634-4113	A94-092

SUBJECT/WORD INDEX TO THE ARMY SBIR SOLICITATION

INDEX OF ARMY FY94 TOPICS

A-1 ADVANCED MATERIALS AND MANUFACTURING (I.E. STRUCTURAL & ENERGETIC MATERIALS)

A94-001 Advanced Tungsten Alloys

A94-002 Modular Omnibus Program With Internal Checking

A94-003 Powder Injection Molding

A94-004 Low Cost Processing of Whisker and Particulate Reinforced, Aluminum, Metal Matrix Composite, Thick Sections

A94-005 Development of Electron-Beam Curable Resins for Primary Composite Structural Applications

A94-006 Functionally Gradient Ceramic-Titanium Metal Materials

A94-007 Nondestructive Evaluation of Advanced Composites and Composites Processing

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A-6 POWER AND DIRECTED ENERGY

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A94-090 Real Time Monitor for Dangerous Air Emissions from Cleanup Sites

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DEPARTMENT OF THE ARMY
FY1994 TOPIC DESCRIPTIONS

A-1 ADVANCED MATERIALS AND MANUFACTURING (I.E. STRUCTURAL & ENERGETIC MATERIALS)

TOPIC: A94-001 TITLE: Advanced Tungsten Alloys
Point of Contact: ARDEC

CATEGORY: Exploratory Development

OBJECTIVE: Develop tungsten-based materials which display sufficiently enhanced terminal ballistic performance so as to replace depleted uranium alloys as material of choice for DOD munition applications.

DESCRIPTION: A new generation of tungsten-based material is needed to exhibit terminal ballistic performances equivalent to depleted uranium alloys. These new tungsten-based alloys will be designed to display an early onset of dynamic plastic instability and flow localization. This may be accomplished by configuring new matrix material and modified and enhanced tungsten particles into particulate composites having appropriate characteristic microstructures and thermomechanical properties that induce the desired flow localization in the material. An alternate concept to promote enhanced ballistic performance in tungsten alloys relies on the orientation aspects and the anisotropic flow behavior of tungsten. Based on the very superior ballistic performance of <100> oriented tungsten single crystals, various approaches may be explored to impart similarly favorable orientation in polycrystalline tungsten and tungsten composites.

Phase I: Demonstrate concepts for advanced tungsten alloys to display dynamic plastic instability and flow localization. Deliver material for evaluation.

Phase II: Scale-up processing, as necessary. Prepare material for high strain rate screening and sub-scale ballistic testing.

Potential Commercial Market: The technology developed under this program will allow advancement in both military and commercial fields. Alternate material will replace the environmentally sensitive depleted uranium in all of the DOD munition application. Particularly, for the Army, this technology can be used in programs such as SADARM, replacement for 829A1 KE round, hypervelocity projectiles and x-rod program. Commercial benefits include the use for gyroscopes, counter balances, semiconductor substrates, radiation shields, machine tools and medical equipment. Operations and Support Cost Reduction: New generation of tungsten alloys developed under this program will markedly reduce the environmental, logistical and life cycle cost burden associated with the present use of radioactive depleted uranium material i n all of the DOD armament components.

TOPIC: A94-002 TITLE: Modular Omnibus Program With Internal Checking
Point of Contact: ARDEC

CATEGORY: Exploratory Development

OBJECTIVE: Develop an modular omnibus program with internal testing (MOPIT) which has the capabilities for designing molecules, modeling various fundamental and applied physico-chemical phenomena associated with propulsion systems and with energetic and non-energetic materials.

DESCRIPTION: Individual Computer codes to model specific propellant systems and solid and fluid propulsion phenomena and associated data bases have been developed at ARDEC. These include software to model equilibrium chemistry (MCVECE), reaction kinetics (PANDORA), reactive chemistry/hydrodynamics (VULCAN), droplet formation and size distribution, and molecular dynamics. Along with these modeling codes, dynamic color graphics have also been developed which give real time visual simulation of the modeling output. In addition, other codes developed elsewhere are also available that predict molecular structure, thermodynamic parameters, and model explosive processes. These codes are used individually at ARDEC to design and characterize energy parameters of new molecules; screen molecules as potential candidate propellant or explosive ingredients and their potential formulations; model propellant combustion and interior ballistic cycles; predict potential propellant and explosive performance; and, model environmental impact. Other military application of these codes include modeling processes involving munitions production, munitions demilling, and their environmental impact. An even greater number of applications are possible in the commercial sector.

Although these computer codes are available, utilizing them in an efficient integrated interactive way is currently not possible without specific detailed knowledge of the individual codes. That is to say that data, parameter and variable compatibility between programs and simulation tasks must be established and maintained. Specifically, what is needed is a program which: 1) automatically examines simulation task requirements against the available modules and their respective functions and input requirements; and, 2) after this examination interrogates the user to supply input that may be lacking or needs modification.

To develop a new propellant, it would be possible to design a candidate propellant oxidizer, predict its thermodynamic parameters, optimize a propellant formulation with a given fuel, simulate its interior ballistic cycle and predict its performance automatically by imputing an educated guess of its molecular structure into a properly structured MOPIT. In a similar fashion, a newly proposed propulsion concept could be modeled so that a rapid economic evaluation of its merit could be made.

Phase I: Develop an initial MOPIT infrastructure. Demonstrate the feasibility of the MOPIT concept utilizing only a few selected programs as a preliminary program library. Perform preliminary MOPIT modeling and simulation investigation of two tasks. Model same tasks with individual unlinked programs and provide analysis which compares the MOPIT results with the results from the individual unlinked programs.

Phase II: Expand the initial MOPIT developed in Phase I by accumulating and evaluating an extensive library of programs to be used in MOPIT. Standardize name convention and units for all variables and constants in the candidate modular programs. Structure MOPIT to be language independent so that it can accept and interact with new programs written in different languages and automatically perform desired modeling. Provide MOPIT software capable of modeling a broad spectrum of tasks which address propulsion related phenomena complete with source code and documentation.

Potential Commercial Market: The software developed under this program can be utilized for any physico-chemical process and therefore has many military, commercial and academic applications. For example the designing and manufacture of exotic materials such as semiconductors and pharmaceuticals could be modeled with this MOPIT. For environmental impact studies the chemistry and physics of processes can be modeled and the evolution and spatial/time path of pollutants c an be tracked.

OSCR: Use of this MOPIT software will provide a means of rapidly evaluating proposed energetic materials and propulsion systems based upon fundamental parameters rather than on lengthily empirical data. This reduces the labor requirements and costs markedly throughout the research and development cycle.

TOPIC: A94-003 TITLE: Powder Injection Molding
Point of Contact: MD

CATEGORY: Exploratory Development

OBJECTIVE: Develop advanced techniques, materials and/or equipment necessary to produce high quality powder injection molded components

DESCRIPTION: Powder injection molding offers the opportunity to form components to net-shape through the use of particulate materials. Usually, a feedstock of metal or ceramic powders blended with molten polymer binders is injected into dies in a manner identical to polymer injection molding. The formed parts in the as-injected molded condition are called "green". After molding, the polymer binder is no longer needed and is usually removed from the formed part by a combination of solvent and thermal debinding; the remaining metal or ceramic powder, brown part, retains the formed shape. These debound parts are then centered in the usual way. Powder injection molding is a process that is capable of producing complex metal and ceramic components at a great cost savings. If the process is to become fully successful then the parts produced must be made with a reasonable degree of confidence in the finished part. That is with a low rate of internal defects and a high level of quality. It must also be produced in a manner that is benign with respect to the environment. Proposals are sought that address the technical problems of powder injection from any of a number of possible avenues. In no particular order, these may include, but are not limited to: (a) NDT of green (as-molded) components, (b) environmentally compatible binders and debinding agents, (c) injection molding od difficult to machine materials, (d) Modeling of the molding process particularly as it relates to final part quality, or (e) any aspect of the process seen as needing investigation.

Phase I: Identify and develop advanced methods for the production of high quality powder injection molded components. Demonstrate the appropriateness of the methods for the applications. Deliver demonstration components produced with the techniques, methods or procedures developed. All Phase I work should concentrate on one or two types of material, e.g., stainless steel, tungsten alloy, intermetallic, composite, ceramic, etc. so as to concentrate on developing the innovation.

Phase II: Work in Phase II should exploit the Phase I success, expand the range of materials and begin to apply the methods developed to production-like situations. This work should highlight the generic nature of the developed material, process or method and deliver prototype or demonstration components. The work in powder injection is inherently dual-use and demonstration components should reveal this aspect of the process.

Potential Commercial Market: The potential market for powder injection molding has been identified to be well over $100 million. Successful expansion of this market will necessitate the production of consistent high quality parts and component s. Development of NDE methods, environmentally compatible materials and processes, and techniques to produce complex or difficult to machine components will facilitate this market expansion.

TOPIC: A94-004 TITLE: <u>Low Cost Processing of Whisker and Particulate Reinforced, Aluminum, Metal Matrix Composite, Thick Sections</u>

Point of Contact: MD

CATEGORY: Exploratory Development

OBJECTIVE: Develop a low cost processing method by which thick-section (>2 inches), near-net shape, discontinuous, ceramic-reinforced, aluminum, metal matrix composites can be produced.

DESCRIPTION: Recent research on the ballistic behavior of discontinuous aluminum metal matrix composites (Al MMCs) demonstrated promising behavior. Results suggest enhanced penetration resistance with a fine grain Al MMC produced by thermomechanical processing over monolithically produced counterparts. Agglomeration of reinforcement along flow lines from deformation processing can be detrimental to spallation. A combination of whisker and particulate reinforcement i n forming a hybrid MMC may alleviate this predicament. Processing such Al MMCs via current powder metallurgy or rapid solidification techniques is relatively expensive, and heat extraction may be an obstacle when using these methods to produce thick sections (> 2 inches). Though low cost wrought and cast Al MMCs are available; their strength, ductility, and toughness are either lower or only comparable to their respective monolithic counterparts. The focus of this topic is to exploit innovative low cost thick section processing capabilities for the fabrication of Al MMCs with the proper microstructure for structural armor applications. The ability to tailor the composite for reinforcement loading and control of the matrix grain size is crucial. Furthermore, the process is required to maintain homogeneous and uniform reinforcement distribution and a fine grain matrix microstructure throughout the thickness up to, but not limited to, 2 inches. The processing system must be flexible to handle all conventional aluminum alloy chemistry, including lithium additions, and should have potential as a continuous process.

Phase I: Demonstrate the feasibility and capability of a low cost processing method with extensive flexibility in process control for tailoring reinforcement loading and matrix grain size while producing thick sections of discontinuous whisker and particulate reinforced AL MMCs. Deliver six 12x12 by at least one inch thick AL MMC plates for ballistic screening tests.

Phase II: Develop optimized processing parameters for whisker and particulate reinforced Al MMC plates (at least 2 inches thick) and thick tubes. Produce and deliver thick section prototypes of armor plates and tubular components for property, microstructural and ballistic evaluations.

Potential Commercial Market: A low cost processing method for producing near net shape, high performance, AL MMC components would attract applications in the automotive, construction and agricultural industries.

TOPIC: A94-005 TITLE: <u>Development of Electron-Beam Curable Resins for Primary Composite Structural Applications</u>

Point of Contact: VSD

CATEGORY: Exploratory Development

OBJECTIVE: Develop electron-beam curable resins for primary composite structural applications.

DESCRIPTION: Fabrication cost is the primary hinderance for the broad use of composite materials to primary structural applications. Structural resins that are both heat and electron-beam curable offer a significant potential for reducing the fabrication cost of primary composite structures. These resin systems should be compatible with yarn powder coating technology and particle toughening technology (i.e., rubber or thermoplastic) to improve damage tolerance. The mechanical properties, both at room temperature and hot-wet conditions, of the cured net resin should be consistent with properties from state of the art structural resin systems used in composite materials.

Phase I: Identify available structural resin systems (applicable to aviation and ground vehicles requirements) that are currently heat and electron-beam curable or can be modified to be heat and electron-beam curable. Conduct mechanical property tests on those resins systems using heat curing, electron-beam curing and a combination of heat and electron beam curing. Identify the most promising resin systems and prepare a detail approach as to how these resin systems can be modified to achieve the desired curing characteristics and mechanical properties.

Phase II: Modify the selected resins and conduct mechanical property tests of the cured neat resin materials. Several modification and test cycles may be necessary. Select one or two resins for evaluation as composite material. Conduct mechanical property tests of the composite materials.

Potential Commercial Market: Structural resins that are both heat and electron beam curable offer a significant potential for reducing the fabrication cost of primary composite structures and would be utilized in all composite manufacturing, both with military and commercial use.

TOPIC: A94-006 TITLE: Functionally Gradient Ceramic-Titanium Metal Materials
Point of Contact: WTD

CATEGORY: Exploratory Development

OBJECTIVE: 1. Expand the existing commercial technical capabilities in functionally gradient materials (FGM) to specific armor-related materials and technology under 6.2 development in WTD. 2. Demonstrate the technical feasibility of ceramic-faced, titanium appliques for use in near-term light and medium vehicle applications where vehicle integration factors are paramount. 3. Emphasize existing FGM technology that has a commercial basis on which to solidify a strong dual-use capability.

DESCRIPTION: STATEMENT OF PROBLEM - The Armor Mechanics Branch has a number of separate 6.2 research programs funded under the ARL's AH80 Armor Technology Techbase program as well as under TACOM's DC05 Passive Armor Technology Program. Two programs of interest have been the development of low-cost titanium alloys for ballistic application and the evaluation of high performance ballistic ceramics. These programs have also been supplemented through various unfunded study agreements with Industry that provide the material support and development. Recently, the amalgamation of these two technologies into functionally gradient materials has been noted by at least two commercial firms that have strong armor materials background. Functionally gradient materials are in homogeneous composites which transition from ceramic to metal in well defined graded layers. While extensive research has been noted in this area worldwide, armor-related research has been limited. The primary application for armor technology is to solve the inherent difficulties of attaching ceramic/metal composites to armored vehicles without losing the high ballistic performance of armor ceramic composites or gaining large parasitic attachment mass which lowers relative system performance. Functionally gradient materials offer solutions for these problems as well as providing a composite material which has strong commercial potential. This topic area would allow the demonstration of this technology for use in near-term applique applications for upgrading the ballistic performance of the existing armored vehicle fleet.

Phase I: 1. Review the existing ceramic database and develop a matrix of ballistic ceramics which could be combined with titanium to form gradient materials. 2. Develop procedures or models to analyze the various material parameters that affect fabrication of functionally gradient materials such as thermal expansion, melting points and relationship to densification temperatures, elastic modules and other inherent material properties. 3. Select one or more representative ceramic/titanium composites and demonstrate the feasibility of the FGM by fabricating samples at least 100mm square or in diameter. 4. Propose the procedures for scaling FGM's to 150mm square tiles as well as further optimizing the FGM which would be used for Phase II ballistic testing. 5. Demonstrate the ability to mechanically attach the FGM to a metallic base armor.

Phase II: 1. Fabricate 150mm X 150mm tiles in various thicknesses to determine the baseline ballistic performance in standardized depth of penetration tests. 2. Optimize the ballistic performance by varying the interface compositions and thicknesses and fabricate improved ballistic tiles for testing. 3. Fabricate a large 450mm X 450mm array that can be mechanically attached to a base armor to demonstrate the multihit ballistic performance in a standardized ballistic test as well as the ability to adapt the design mechanically to a base armor.

Potential Commercial Market: The current commercial applications of functionally gradient materials of ceramic-titanium are large because the inherent metal base of the material is retained simplifying the mechanical/fabrication aspects of an application but allowing the high performance use of the ceramic facing. The materials have inherent high strength and net shape forming is also possible which reduces fabrication costs. Some applications include:

1. Improved machine tools with high fracture toughness which can be easily attached in fixtures.
2. High temperature aerospace components for improved wear resistance or for lightweight engine protective shroud materials.
3. Reduced weight automotive components such as brake linings or replacement of high wear components in the drivetrain.

TOPIC: A94-007 TITLE: Nondestructive Evaluation of Advanced Composites and Composites Processing
Point of Contact: ARO

CATEGORY: Basic Research

OBJECTIVE: Develop nondestructive approaches for characterizing the integrity of polymer composites and/or diagnostics for monitoring the processing of advanced composites employing either positron annihilation or advanced laser diagnostic techniques.

DESCRIPTION: Develop and demonstrate nondestructive approaches for characterizing the integrity and/or diagnostics for monitoring the processing of advanced polymer-based composites using either positron annihilation or advanced laser diagnostics. Research is needed to provide real-time processing diagnostics and nondestructive evaluation of polymer-based composites. This program is directed at improving the reliability and lowering the costs associated with the manufacture and life-cycle use of advanced polymer composites.

Phase I: Identify potential characterization techniques and complete proof-of-concept experiments. A commercialization path should be outlined.

Phase II: Design, build, and operate a prototype characterization instrument. Explore major cost and applicability issues associated with commercialization of the system.

Potential Commercial Market: High performance polymer composites are expected to find broad commercial applicability to the auto and construction industries. This research will seek to provide low cost production and inspection techniques that will facilitate the commercialization of polymer-based composites

TOPIC: A94-008 TITLE: Rapid Development of Complex Helicopter and Turbine Engine Components
Point of Contact: AVRDEC

CATEGORY: Exploratory Development

OBJECTIVE: Develop a design/manufacturing system which can rapidly generate a functional model of an aerodynamic or mechanical component which can be subjected to limited performance testing.

DESCRIPTION: Due to the complexity of modern weapons systems, the time and costs associated with their successful development and qualifications are rapidly becoming unaffordable. A revolutionary improvement in affordability could be realized if a prototype model of critical system components could be rapidly produced and subjected to proof testing. Furthermore, the ability to conduct early tests would allow many more iterations of a design to be conducted, thus improving reliability and allowing early incorporation/evaluation of maintainability features. The 3-D solid models available using stereolithography, currently the most popular rapid prototype method, have very poor strength, ductility, surface finish and dimensional stability over time. An advanced process or technique which significantly improves these deficiencies and provides high temperature (150-250 degrees F), strength and ductility is desired. Fabrication of the model from ceramic cast metals, powdered metals, high-strength engineering plastics would potentially improve some of these limitations. Processes which rapidly produce models using additive processes or advanced casting methods will be considered. It is desired that these models (scaled or full scale) be suitable for airflow, vibration, and potentially heat transfer and limited structural testing. For example, scale models of compressor rotors, gearbox housings and structural mounts for electronic sensors can currently be produced in less than ten hours using stereolithography. Due to the limitations of the model material and the relative accuracy versus the actual part, the model is unsuitable for testing. The ability to go from a solid model to a prototype, testable model in 3 to 5 days is desired.

Phase I: Develop a design for a rapid prototyping system capable of producing solid models suitable for limited functional testing. The system should be able to utilize geometric data from currently used computer aided design (solid modeling) systems. The system should produce models with strength, dimensional accuracy, and thermal stability significantly above those currently available utilizing stereolithography. The effect of process variations on accuracy and stability shall be determined. Unique technical aspects of the system design should be demonstrated by bench testing. Results of this testing will be used to evaluate the concepts potential for successful development. Small gas turbine engine components such as cooled turbine blades, compressor rotors/blades along with aircraft structural components such as weapons an sensor installations and environmental control systems installations are or primary interest.

Phase II: A detailed design of the entire rapid prototyping system shall be conducted. A prototype of this system shall be fabricated. Gas turbine engine or airframe manufacturers shall be contacted to obtain trial part geometries. Several different trial parts shall be prototyped and subjected to functional testing. The ability of these tests to reproduce the component performance characteristics shall be evaluated. Potential Commercial Markets: If successful, the technology resulting from this topic would be applicable to a vast array of commercial products/markets. Companies producing aircraft, ground vehicles, gas turbines, internal combustion engines, electric motors, and many other commercial and residential products involving mechanisms and/or energy conversion would greatly benefit. All the major producers of the above products employ rapid prototyping systems to some degree in their current development activities. A system with the advantages to be developed by this topic would allow these companies to drastically reduce the time and cost of bringing new, high-quality products to market. A direct competitive advantage would be gained by companies utilizing this technology.

TOPIC: A94-009 TITLE: Evaluation of Reinforced Elastomers as Erosion Resistant Coatings for Rotor Blades
Point of Contact: AVRDEC

CATEGORY: Exploratory Development

OBJECTIVE: Investigate an alternate approach in the design and development of material concepts that will combat the combined effects of wind and rain erosion on helicopter rotor blades.

DESCRIPTION: Rotor blade erosion has been a chronic problem for the Army and other services for many years. The problems associated with sand and rain impingement on blade leading edges and surfaces have resulted in severe damage and the resultant expenditures to replace, repair and maintain blades have been significant. The severity of the sand erosion problem was recently demonstrated in the Middle East during the Desert Shield/Desert Storm conflict.

An optimum erosion system for a rotor blade requires a design that is effective in both rain and sand environments. Testing performed to date shows that metallic (hard) erosion systems perform best in rain, and nonmetallic (soft/pliable) materials perform best in sand. An acceptable protective design compromise capable of extended performance in both sand and rain has yet to be fielded. In view that work directed toward solving this problem has been ongoing since early 1960 it appears that a new design approach, directed to achieve an optimum system, is warranted.

The elastomer (urethane, estane, etc.) stripping or boot applied to the rotor blade leading edge for sand protection lends itself, by its inherent physical characteristics, to modifications that will provide total erosion (sand and rain) protection. Metallic erosion protection systems, on the other hand, can only be enhanced by increased hardness and therefore do little to combat sand erosion.

This proposed effort will investigate the potential of enhanced rain erosion protection of elastomer matrices, already proven to have good sand erosion characteristics, by introducing fabric, fiber or mesh laminations to reinforce the elastomer and distribute the loads and deformations associated with rain impingement.

Phase I: The work to be conducted during this phase would use the analytical developments available from recent studies concerning the theories and mechanics of erosion on helicopter rotor blades and other aircraft systems to design and evaluate the integration of fiber and fabric reinforcement into elastomers already proven to have good sand erosion resistance. Reinforcement materials to be included in this study would include composites of varying denier, weave an d stiffness. Positioning (depth) of the reinforcement laminate within the elastomer, physical characteristics (durometer, thickness, etc.) of the elastomer on either side of the reinforcement laminate, and the use of multiple layers of reinforcement and elastomer will be addressed. A briefing describing the work conducted in this phase and recommendations regarding material concept designs which should receive additional consideration (fabrication and test) will be provided. Upon Government approval test coupons representative of these designs will be fabricated and subjected to rain erosion tests. Results will be compared to previous work and ongoing tests conducted at the Wright Laboratory Rain Erosion Test Facility at Wright-Patterson AFB.

Phase II: Upon successful completion of the Phase I testing additional test specimens will be tested in a designated sand erosion test facility to assure that the addition of the reinforcement material has not sacrificed the original sand erosion resistance. Upon successful completion of the sand erosion tests, a manufacturing process development task will be undertaken to define possible full-scale fabrication techniques of the erosion resistant material concept. A full-scale set of prototype rotor blade erosion resistant tapes/boots will be fabricated for ground and flight test.

Potential Commercial Market: The results of this SBIR are applicable to both the helicopter and fixed wing commercial aviation industry. Erosion protection of wing leading edges and radomes are typical examples.

TOPIC: A94-010 TITLE: In-Situ Composite Cure and Processing Transducers
Point of Contact: AVRDEC

CATEGORY: Exploratory Development

OBJECTIVE: Develop, characterize, and demonstrate inexpensive, durable, accurate sensors and transducers capable of monitoring, in-situ, the exact rheological state of a composite laminate throughout the entire injection (if appropriate), cure, and post cure inspection process. Sensors that can remain serviceable and useful in the cured structure, for use as a structural integrity monitor (damage, strain, etc.) are desirable.

DESCRIPTION: Currently, composite structural laminates are processed and cured based on idealized pressure and temperature profiles. Some attempts have been made to equip composite molds with acoustic, pressure, or temperature transducers, but these designs rely on extrapolation of surface condition data to estimate the rheological condition of the entire laminate. Sensors that are embedded into the laminates in critical areas, such as in thick areas and joints, that do not adversely affect the quality of the laminate will provide more accurate status for active or intelligent cure monitoring and control systems. Additionally, sensors that remain in the cured laminate may be valuable to assess the quality or integrity of the laminate for inspection purposes in production and in the field. Sensor development for directly measuring Tg, % cure, viscosity, etc., rather than using related parameters is desired. Development of in-situ sensors will support S&T Thrust #7 Technology for Affordability, and Structural Integrity Program objectives.

Phase I: Using the chosen sensor concept, define and quantify the appropriate thermoset, thermoplastic, or other polymer resin rheological parameters that are necessary to determine the exact state of cure of that system during processing and cure. Test and characterize the candidate sensor designs' sensitivity and accuracy in measuring the identified critical parameters. A final technical briefing summarizing the results and conclusions of the contract work will be presented to the Government at the Aviation Applied Technology Directorate, Fort Eustis, Virginia.

Phase II: Fabricate and test prototype sensors in-situ in composite laminates during optimum and anomalous cure cycles. Material characterization of the correctly cured laminates will be used to calibrate the sensors' performance. Interrupted, terminated, or otherwise anomalous cure cycles will be completed to demonstrate the sensors' ability to accurately diagnose the cure state of the laminate and monitor the remaining processing to achieve adequate structural integrity. Additionally, where appropriate, demonstrate the sensors' utility as an inspection (quality control) device or health (strain, damage) monitor.

Potential Commercial Market: Considerable cost allocations for composites fabrication are inspection, scrap, and rework due to anomalous cure cycles or inadequate inspection procedures. Inexpensive cure monitoring will allow cure cycles to be performed in the shortest, most efficient manner, and improve laminate qualities accordingly, thereby lowering the overall cost of composite structures fabrication.

TOPIC: A94-011 TITLE: Advanced Materials for Attenuation of Low-Energy Laser Radiation
Point of Contact: NATICK

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate innovative materials and structures that utilize optical, electrical, or other mechanisms to reduce the intensity of laser beams to a safe level, in a manner that causes no more than insignificant interruption of the normal functioning of the eye or other light-sensing device.

DESCRIPTION: Numerous laser devices are found in the armed forces of all nations, and unknown numbers of such devices are found in various insurgent and independent armies. The eyes of the soldier, and the many sensors essential to the combat effectiveness of our fighting forces concentrate the energy from these low-energy devices. The resulting high concentration of laser energy is capable of damaging the retina or the sensor. Protective devices thus far developed, utilizing fixed filters of some type, provide a useful but limited level of protection against one, two or three laser wavelengths, usually with a significant loss of vision caused by reduction in the overall level of light transmitted.

Phase I: Investigate new materials and structures that interrupt or attenuate low-energy laser beams from devices operating at one or more wavelengths, reducing the residual energy to a level that causes negligible damage to the retina or sensor. Structures that have shown some promise in the past include rugate filters and non-planar holographic structures for several fixed wavelengths, as well as nonlinear optical materials and lens arrays for tunable lasers. Each of these has shortcomings. In the first phase of the proposed SBIR, a specific approach to laser eye protection is to be developed, and a demonstration device incorporating the approach is to be built. The device should have a visual transmittance of at least 50% in its normal or unactivated state. An effective optical density of 4 throughout the designated spectral region should be attained within 30 nanoseconds of the initiation of the laser pulse.

Phase II: The concepts developed in Phase I should be incorporated into a complete system of headborne eye wear providing the specified level of laser protection. The device should be as lightweight and compact as is feasible, and should exhibit maximum durability with available materials.

Potential Commercial Market: Lasers, and devices using them, are becoming commonplace in several commercial applications. For example, the use of lasers in surgical procedures calls for protection against the laser wavelength with maximum transmission of all other visible light. In laboratories where several types of lasers are in use, efficient blocking of multiple wavelengths may be required. In this case, the requirement for a high level of light transmission is even more difficult to meet. The technology developed under this SBIR should be applicable to these and other commercial uses.

TOPIC: A94-012 TITLE: New Helmet Materials for Increased Ballistic Protection
Point of Contact: NATICK

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate an improved lightweight material system with increased protection against multiple ballistic threats for helmet application.

DESCRIPTION: Current helmets fielded for Army use are designed to provide a high level of protection against fragmentation-type threats. However, as the world scenario changes, the ballistic protection offered to the individual soldier must adapt to the changing threats. Certain Army elements already are looking to upgrade protective requirements and are suffering the penalties associated with standard materials. The objective of this effort is to investigate combinations of new and/or existing materials technologies for potential application in helmets that will maintain current levels of fragmentation protection, and without substantial weight penalties, increase the performance against other ballistic threats, such as small arms rounds. The overall goal of this effort will be to improve the capability of the soldier (endurance, survivability, mobility and lethality) though the development of an optimized materials system for maximized ballistic performance against multiple ballistic threats.

Phase I: Identify and explore novel concepts with potential for meeting ballistic performance and weight requirements. Design and develop a "breadboard" system and prove feasibility of material system through laboratory tests including ballistic evaluation.

Phase II: Optimize selected Phase I system and demonstrate weight and fragmentation resistance comparable to Personnel Armor System for Ground Troops helmet with increased protection against small arms (.30 caliber) projectiles. Produce prototype helmets for delivery to government for full ballistic and durability evaluation. Provide final technical report will full specification for optimized system(s).

Potential Commercial Market: This technology will be directly applicable to the law enforcement armor industry.

TOPIC: A94-013 TITLE: Development of Flexible Materials System for Small Arms Defeat
Point of Contact: NATICK

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a flexible material system or materials application configuration for body armor designed to protect against multiple ballistic threats including fragments and small army ammunition.

DESCRIPTION: Along with weight and bulk, flexibility is a key consideration in user acceptability of body armor items. Research and development efforts are ongoing to develop lightweight materials systems that provide a high level of ballistic protection against multiple ballistic threats. Flexibility is typically inherent in the materials used to protect the individual soldier from fragmentation-type threats. A configuration has also been developed and demonstrated that allows for a flexible application of the rigid-composite materials required to defeat flechettes. The ceramic- and metal-based composites currently used to protect against small arms threats (.30 caliber) present technical barriers (e.g., physical structure, thickness, failure mechanisms) that inhibit their application in a flexible manner. Significant advancements are necessary to accomplish the development of a flexible system that maintains acceptable performance against small arms threats without adversely impacting the overall weight of a system. Potentially, there are at least two approaches to addressing this problem: 1) the development of a new lightweight material system that is inherently flexible, or 2) the development of a method or technique to apply current or emerging rigid materials in a flexible configuration without compromising performance or weight. The first approach is considered to be the most technically challenging since data to date supports the need for a rigid materials to defeat these kinetic energy rounds.

Phase I: Identify and explore novel concepts with potential for meeting objective. Design and develop a "breadboard" system and prove feasibility of technique in laboratory tests including ballistic evaluations.

Phase II: Produce and optimize selected system(s). Complete full evaluation and provide final technical report with full specification for optimized system(s).

Potential Commercial Market: This technology will be directly applicable to the law enforcement body armor industry.

TOPIC: A94-014 TITLE: Flexible Bulk High Temperature Superconductive (HTS) Material with High Critical Current and High Critical Power Handling Capability

Point of Contact: CECOM

CATEGORY: Advanced Development

OBJECTIVE: To improve the electrical characteristics of the newly-developed flexible bulk superconductors to enable them to work in the high frequency A.C. and high power and current regimes.

DESCRIPTION: The family of modern high temperature ($T > 77K$) superconductors is made of copper oxides of Yttrium, Lanthanum or Bismuth. They make possible myriads of applications in military and commercial electronics applications. At the present tim e their shape constrains their usefulness. Bulk Yttrium, in particular, can only be manufactured into straight segments while retaining its extraordinary electrical properties. Bismuth's crystal morphology on the other hand, allows considerable bending of the bulk wire, but taxes in current density and frequency. The industrial sector is invited to continue its research and exploratory development in order to produce a superconducting material capable of being warped or bent, so it can be applied to various communications electronics components requiring selected three dimensional geometries and sizes.

Phase I: This phase shall establish a proof of concept that flexible superconductive bulk wire can be made, especially to be formed into a helical shape.

Phase II: If a feasible approach is determined, develop and demonstrate a prototype model using this hardware.

Potential Commercial Market: The entire communications industry, general electronics industry and even most of the high power applications will benefit immediately from this innovation. The demand for more complex type superconductor is spiralling up.

TOPIC: A94-015 TITLE: Advantages of Sol-Gel Glass Technology for Processing 100% Silica Optical Fiber Waveguides

Point of Contact: CECOM

CATEGORY: Exploratory Development

OBJECTIVE: To develop a process for the manufacture of optical glass fiber, and more specifically relates to a novel process in which glass precursor coatings are formed on a continuously moving filamentary core of material which is removed from or become s an integral part of the ultimately formed optical fiber.

DESCRIPTION: Conventional preforms require complicated processing steps and repeated batch-type handling and increase the cost of the ultimate fiber. Thus, the preform may constitute 75% of the cost of the fiber. Furthermore, since fiber is drawn from a r od of given volume, the length of the fiber which can be drawn is limited. This increases the number of optical couplers and amplifiers needed to connect a number of relatively short segments into a very long signal path. An optical fiber shall be formed by continuously coating a precursor core filament with a glass-forming coating. The precursor's volatile host shall be continuously processed to convert the coating to a glass, with the core either removed from the fiber during glass forming or becoming an integral part of the ultimate fiber during glass forming. The glass fiber shall be densified in a continuous process. The fiber shall be provided with a protective coating as it moves through a stationary coating station and the completed optical fiber is continuously reeled.

Phase I: A thorough investigation of the state of the art processing for volatile organic fibers or filaments that will allow for sol-gel glass coating to be vitrified onto a volatile host into an optical silica glass fiber having the low optical loss and high mechanical (tensile strength) equivalent to its conventional fiberizable glass preform.

Phase I: Will continue on-going R&D efforts of phase I aimed toward the production and commercialization of low cost optical glass fiber.

Potential Commercial Market: This process shall eliminate the expensive fiberizable glass preforms used in military and commercial applications for communication systems. It will also utilize domestic U.S. materials for processing a non-preform fiber which currently depends on foreign sources.

TOPIC: A94-016 TITLE: Non-Toxic Self Lubricating Materials for Automotive Applications
Point of Contact: TACOM

CATEGORY: Exploratory Development

OBJECTIVE: Develop non-toxic, environmentally compatible, self-lubricating materials for automotive components.

DESCRIPTION: The use of hazardous materials like lead in automotive components is an increasing cause for concern due to the cumbersome methods and costs associated with the disposal and handling of these components. New materials that are non-toxic and environmentally safe are desired. The materials must be readily available, inexpensive and easy to manufacture into complicated shapes without sacrificing the lubrication capabilities.

Phase I: Develop techniques for producing self lubricating materials for use in automotive applications. Perform limited life cycle tests and conduct cost comparisons with existing materials.

Phase II: Produce sufficient quantities of materials needed for fabrication and testing of components; perform engine bench tests; conduct limited tests of components on fielded vehicles; and, evaluate component performance and costs.

Potential Commercial Market: Environmentally compatible, self lubricating materials have numerous uses in bearings, bushing, sleeves and other moving mechanical assemblies in the automotive, machine tool and aerospace industries.

A-2 MICRO/ELECTRONICS AND PHOTONICS

TOPIC: A94-017 TITLE: Components for Optical Control of Millimeter Wave Systems
Point of Contact: E&PSD

CATEGORY: Exploratory Development

OBJECTIVE: Development of key components for optical linking and control of advanced millimeter-wave systems for future Army radar and communication applications.

DESCRIPTION: Future Army requirements for the digital battlefield, mounted battle lab and communications on the move will require the use of optical fiber connecting links between a central processor and remote amplifiers and antennas. In various system designs these links may carry a transmitted or received radio frequency signal, a down- converted signal, a reference signal, or a control signal. The millimeter-wave frequency range of interest is 35 to 100 GHz. One example of such a system using optical links would be a phased array radar where individual amplifiers located at the antenna elements receive their rf exciting signal through a fiber link. Key components for such systems include modulators (either direct or external modulation of lasers), detectors, low loss switching networks, and optically controlled amplifiers. Innovative device concepts and techniques in these areas are sought. New millimeter wave optical devices must possess excellent stability and be capable of operation over the Army environment range. Chip level integration of millimeter and photonic devices is the ultimate goal.

Phase I: Develop a selected device concept through analysis of expected fabrication techniques and device performance. At the end of Phase I a report of device design, simulated performance, and expected fabrication process should be delivered to the government.

Phase II: Fabricate and test the devices developed in Phase I. The fabrication processes developed in this phase should be compatible with MMIC processing. Devices for testing by the government will be provided throughout this phase.

Potential Commercial Market: Civilian applications include phased array antenna systems for satellite based communications, aircraft radar systems, and automotive collision avoidance radars.

TOPIC: A94-018 TITLE: Hybrid Diffractive-Refractive Optical Elements
Point of Contact: S3I

CATEGORY: Basic Research

OBJECTIVE: In this Phase I effort, new design techniques for hybrid diffractive/reflective lenses will be investigated that can improve image quality, diffraction efficiency, and performance over wavelength.

DESCRIPTION: Diffractive Optical Elements (DOEs) are useful in performing a number optical processing functions such as array generation in image morphology and as filters for pattern recognition. In combination with refractive elements, diffractive optic al elements can be useful in packaging to reduce weight, improve image quality, and extend performance over wide temperatures.

Phase I: In the Phase I study, novel design techniques which combine the properties of refractive and diffractive elements will be proposed and investigated. Investigation will consider optical performance and manufacturability. A final report will be generated which describes the results and the likelihood of success in Phase II.

Phase II: Upon successful completion of the Phase I objectives, prototype elements will be fabricated and tested in Phase II.

Potential Commercial Market: DOEs can be useful in a variety of military and commercial applications. In the commercial sector, DOE's are useful in optical data storage, optical interconnects, and interocular lenses. In military systems DOE's can be used in optical processing, infrared imaging, and helmet- mounted displays.

TOPIC: A94-019 TITLE: Programmable Microwave Fiber-Optic Delay Line Network
Point of Contact: SLAD

CATEGORY: Exploratory Development

OBJECTIVE: Research and develop a fiber optic delay line network capable of providing a digitally programmable delay of wideband microwave signals.

DESCRIPTION: Current microwave delay line technologies based on bulk wave devices, surface acoustic wave devices and digital RF memory (DRFM) systems have performance limitations that render them unsuitable for wideband microwave signal processing and other applications. Fiber optic technology offers a viable alternative with the potential for greatly improved system performance along with reduced complexity, size and cost. The objective of this effort would be to research, develop and deliver a prototype microwave delay line system utilizing fiber optic technology with the following technical goals:

1. Signal bandwidth: > 16 GHz
2. Signal dynamic range (noise floor to input 1 db compression: > 40 db
3. System gain: 0 db +/- 1.5 db over Signal Bandwidth
4. Delay variability: 0 to 655.34 microseconds, digitally programmable in steps of 20 nanoseconds
5. Delay switching speed: < 1 microsecond for any delay change
6. Minimum throughput delay: < 20 ns
7. Spurious products including triple transit response: -35 dbc or lower
8. Operating temperature range: 0 to +50 C

9. Delay variation over operating temperature range: < 1 nanosecond
10. Reduced size, power requirements and cost compared to DRFM technology

Phase I: Research, develop and propose a system design with the potential of realizing the goals in the description above, favoring proven technologies to minimize technical risk. Develop technical specifications for all system components and identify them as commercially available or to be developed. Model and predict the performance of the proposed system, identifying critical components to be developed. Conduct detailed theoretical and laboratory investigations on the design and performance of critical components to demonstrate the feasibility and practicality of the proposed system design. Deliver a report documenting the research and development effort along with a description of the proposed system and specifications for all system components.

Phase II: Procure or develop the system components specified in Phase I. Fabricate the prototype microwave delay line system as proposed in Phase I. Characterize and refine the system performance in accordance with the goals stated in the description above. Deliver the prototype system along with a report documenting the system theory, design, component specifications, performance characterization and recommendations for system refinements.

Potential Commercial Market: Technologies exploited and advanced by this effort include wideband microwave modulation and demodulation of laser light, high speed optical path switching, and the development of low loss delay techniques for wideband microwave signals. All of these technologies have extremely wide commercial application to the development of wideband computer local area networks, telecommunications systems and microwave signal processing for spread spectrum communication and radar systems.

TOPIC: A94-020 TITLE: Optical Fiber Coupled Integrated High-Low Energy Laser
Point of Contact: WTD

CATEGORY: Exploratory Development

OBJECTIVE: Development of an integrated laser system which can deliver both intense high energy laser pulses and low energy high-peak power laser pulses from the same device. The single unit will be controlled with a microprocessor.

DESCRIPTION: A dual purpose optical fiber coupled integrated high-low energy laser is desirable. A small modular laser system which can generate intense high energy laser pulses capable of igniting energetic solid and liquid propellants, welding and cutting metals such as titanium and used in industrial materials processing differs from a low energy system which can be used for optical communications. A single laser system which can operate in both regimes to produce 5 millisecond, 20 Joule laser pulses (such as from a Nd:YAG) or millijoule infrared laser pulses (such as from a diode laser) is required.

Phase I: Design dual purpose hybrid laser system. Bench top construction of proof-of-principle system desirable.

Phase II: Electronic circuit design, integrate high energy and low energy laser technology to fabricate compact system.

Potential Commercial Market: The system will have excellent commercial market applications in the areas of telecommunications, industrial in-process control, laser welding, laser marking and writing, laser surgery, laser dentistry, etc. The system can also be used for commercial blasting applications (mining, demolition), programmed initiation; all electrical connections to high explosives eliminated by replacing wires with glass optical fibers, which are invulnerable to stray electromagnetic fields. Wires often break. Low energy laser pulse can be used to verify integrity of fiber prior to high energy pulse which is used for initiation. Optical fiber probe and low energy laser pulse can be used to locate blockages in arteries, high energy laser pulse can be used to remove blockage. Commercial applications also include laser pyro-actuated rescue equipment such as the "Jaws-of-Life" which are being designed to use a laser initiated pyrotechnic charge in place of the hydraulic lines. Military applications include laser igniters for large caliber guns (Regenerative Liquid Propellant Gun, Unicharge), Rocket Motor ignition (MICOM RELEVANCE) and high explosives initiation.

TOPIC: A94-021 TITLE: Advanced Thermoelectric Materials for Refrigeration and Cryogenic Cooling Systems
Point of Contact: ARO

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate new and innovative thermoelectric materials for use in refrigeration and cryogenic cooling systems. This program is directed at vastly improving the efficiencies of existing thermoelectric cooling systems and providing an alternative technology which can eliminate the environmental problems associated with the atmospheric release of the chlorofluorocarbons (CFC's) currently used in all conventional refrigerant and cooling systems.

DESCRIPTION: Develop new thermoelectric materials with figures of merit (ZT) roughly 7x greater than the present state-of-the-art materials for utilization in advanced refrigeration systems. To accomplish this objective, innovative new approaches to materials development will be required. One possible approach is to adapt superlattice concepts already utilized in semiconductor microelectronics to the field of thermoelectrics. The approach affords the potential for bandgap engineering and delta doping of thermoelectric superlattice structures to vastly improve on electronic carrier mobilities. At the same time the superlattice structure should degrade the lattice thermal conductivity of the material system by increasing phonon scattering from the added interfaces and differing atomic masses. This combination of higher electronic and lower thermal conductivities directly translates into potentially large gains in the overall thermoelectric performance. Such an effort would lead to the development of new materials with large potential ZT enhancements. This would provide efficient thermoelectric coolers to temperatures below 100K for cryogenic sensor and electronic applications, and would permit the direct substitution of all current CFC-based air conditioning and refrigeration technologies by thermoelectric cooler systems with plug compatible efficiencies.

Phase I: Investigate innovative approaches to obtaining advanced thermoelectric materials with figures of merit (ZT) roughly 7x greater than the present state-of-the-art materials.

Phase II: Implement the new materials into a thermoelectric cooler. Design and test a prototype system. Explore major cost and reliability issues associated with producing a material suitable for construction of a commercially viable cooling unit.

Potential Commercial Market: This technology would have immediate application to the commercial air conditioning and refrigeration industry. It would also make feasible cryogenic electronics and computing, affording new opportunities for implementing device concepts based on superconductivity and other low temperature phenomena.

TOPIC: A94-022 TITLE: Multisensor Inspection for Microelectronics
Point of Contact: MICOM

CATEGORY: Exploratory Development

OBJECTIVE: Develop techniques for sensor fusion between multiple inspection methods for subminiature electronic

DESCRIPTION: A number of inspection techniques exist for inspecting electronic assemblies such as printed wiring boards and multi-chip modules. These include x-ray, infrared, ultrasonic, and 3-D x-ray. Often, there is a trade-off between equipment sensitivity and reliability of finding defects: higher sensitivities find more defects but cause more false alarms. A system architecture and algorithmic approach is required for fusing image data from multiple inspection methods in essence to increase the signal-to-noise ratio in the data. This should increase the probability of finding defects, reduce the incidence of false alarms, and possibly allow discrimination between various defect types. Real-time image processing, neural networks, fuzzy logic, and rule-based systems, or a combination of these, should be considered.

Phase I: Requires concept exploration, review of current literature, feasibility study, and development of proposed system architecture/algorithms. Development of a System Concept Document (SCD), which must include a consideration of necessary hardware, multi-system inspection data fusion techniques, programming strategy, and applicable statistical analysis.

Phase II: Phase II would consist of preparation of detailed design drawings, collection of data from proposed individual inspection systems, development of pseudocode to implement algorithms, and assembly of a prototype system. Prototype design will be verified by inspecting example electronic assemblies.

Potential Commercial Market: The technology proposed is widely applicable to commercial electronic inspection requirements. The computer, telecommunications, and consumer product industries depend heavily on state-of-the-art microelectronics to remain competitive in these highly contentious areas. Their requirements for high-density interconnect inspection are just as demanding as those for military weapons systems. Assuring the quality of the interconnects between these increasingly micro-scale components and the substrates that carry their signals to other components and the outside world will be next to impossible using current single-sensor and visual techniques.

TOPIC: A94-023 TITLE: Computational Vision Models for Virtual Reality and Photo Realism Applications
Point of Contact: TACOM

CATEGORY: Exploratory Development

OBJECTIVE: Develop high fidelity, high resolution, color imagery for interactive training devices including target acquisition simulators and other virtual reality applications.

DESCRIPTION: Computational vision models of human perception are uniquely suited in determining the optimal scene content necessary for performing various visual performance tasks. Virtual reality simulations need some performance measures which determine the optimal configuration of various cue features important for object detection and recognition. Interactive training devices, for example, such as flight, driving, and target acquisition simulators need to challenge the human participants at the limit of t heir capabilities in order to avoid making the task either too difficult or easy. The devices need to adapt to individual subject performance by enhancing or reducing conspicuity of critical scene features and background clutter, while retaining the overall realism of the original imagery. Computation vision models are uniquely suited to this task because they predict human performance based upon first principle models of human perception. Performance is directly formulated in terms of individual channel signal to noise characteristics in order to prioritize cue features for specific tasks.

Phase I: Demonstrate software feasibility on a Silicon Graphics Workstation using a computational vision model of human perception. The demonstration should incorporate full color, high spatial and temporal resolution scene features and apply specifically to target acquisition applications.

Phase II: Design and build a full scale hardware implementation of the computational vision model which uses conventional off the shelf computer graphics workstations. Demonstrate the applicability of the software to several virtual reality applications including driving, automotive conspicuity, and higher level object discrimination.

Potential Commercial Market: The Computational Vision Models of early vision have many dual use commercial applications including photo realism and virtual reality, photo interpretation, machine vision, conspicuity analysis for collision avoidance and automotive driving simulation.

TOPIC: A94-024 TITLE: Real Time Wavelet Transforms for Pattern Recognition Applications
Point of Contact: TACOM

CATEGORY: Exploratory Development

OBJECTIVE: Develop a real time wavelet transform processor for the analysis of spatial and temporal signals.

DESCRIPTION: Wavelet transforms can adaptively filter position-varying spectra for local spectral information. The resulting frequency decomposition is particularly appropriate for pattern recognition and texture segmentation of 1-D signals and 2-D imagery. The adaptive window size allows the wavelet transform to zoom on discontinuities, edges and other types of cue features where an optimal combination of local amplitude and phase information is essential for a high fidelity temporal and spatial representation. The constant Q property of wavelet band pass filters leads to a sampling in the scale dimension which is exponential and can be implemented with fast algorithms. A discrete signal decomposition into a complete, orthogonal set of wavelet basis functions is very useful for characterizing general signals using a very small number of wavelet coefficients. A software configuration should include a performance measure (i.e., entropy) for an optimal segmentation of Heisenberg phase into individual signal cue features using conventional wavelet transform implementations.

Phase I: Demonstrate software feasibility of 1-D and 2-D real time wavelet transforms using a Silicon Graphics Work Station. The demonstration should incorporate 1-D acoustic signals and 2-D visual and thermal imagery of Army ground vehicle systems. Evaluate the feasibility of a real time processor for a phase 2 effort.

Phase II: Design and build a full scale hardware implementation of a real time wavelet transform processor which uses conventional off the shelf computer graphics workstations. Demonstrate the applicability of the hardware and software configuration to several commercial and military signal processing applications.

Potential Commercial Market: Wavelet analysis has many dual use applications relating to acoustic analysis for commercial sound applications, seismic analysis for oil exploration, image compression for high density TV, and object recognition.

TOPIC: A94-025 TITLE: Simplified Environment for Insertion and Extrapolation of Low Observable Material Signatures into Photo-Realistic Imagery
Point of Contact: TACOM

CATEGORY: Exploratory Development

OBJECTIVE: Tradeoffs of various signature management materials reflectance characteristics can be difficult due to the complexity to the spectral reflectance and bi-directional reflectance when put into the open environment. A simplified technique is required to make these tradeoffs without completing a full parametric evaluation with large signature models for all environmental conditions.

DESCRIPTION: The visual thru thermal bands, .4-14 microns, is a large span of wavelengths to balance signature management materials spectral reflectance to match a specific background. Surfaces can be described in terms of diffuse and specular reflectance. When materials applied to ground vehicle systems in the open environment, specular reflections play an important role in the overall signature of the vehicle. By tailoring the materials applied the surface may be more or less specular. The bi-directional reflectance is also an important quantity to accurately represent a surface. The reason is that the sky is not uniformally luminated. So at various angles to which a vehicle is viewed the energy received at the eye/sensor is a combination of the integrated sky convolved for each vehicle facet, for each sky angle. In some cases an additional term of the foreground must be included in the calculations.

Phase I: Develop a technique to model narrow band spectral and bi-directional reflectance. Combining this model with environmental effects such as sun, sky and foreground. Calibrate the model with environmental examples for each spectral band.

Phase II: Implement the basic model to handle full vehicle common geometry including FRED facet, IGES128 and IGES114 entities. Include detailed spectral calibrated sky and ground model.

Potential Commercial Market: This technology would have application to building design for a total solar energy passive solutions. Tradeoffs must be made with respect to chromaticity, thermal absorbitivity for pointed surfaces as well as coating for glass surfaces.

A-3 SENSORS AND INFORMATION PROCESSING (I.E. COMMUNICATIONS)

TOPIC: A94-026 TITLE: Scanning Linear X-ray Tube
Point of Contact: ARDEC

CATEGORY: Advanced Development

OBJECTIVE: Develop a family of x-ray tubes in which the electron target is long and narrow.

DESCRIPTION: Standard x-ray tubes use a point electron target with x- rays with x-rays emitted at some angle from the normal to the electron target. DIGIRAY builds an x-ray tube whose target is the face of a CRT with x-rays emitted forward from the face of the CRT in a raster scan fashion. IMATRON builds an x-ray tube whose target is a large arc supporting medical tomography. This solicitation is for the development of a family of x-ray tubes in which the target would be a long straight line and scanned in linear fashion, similar to the IMATRON tube. The family should include tubes that have electron targets of various lengths, ranging from about ten centimeters to one meter or more. The scanning of the target, beam current and accelerating voltage of the tubes must be electronically controllable from a microcomputer. Scanning rates should be greater than sixty scans per second. The range of accelerating voltage should be from 20 KeV to 180 KeV and higher. Tube currents within the family should range from one milliampere to several hundred milliampere . The effective spot size of the x-ray beam must be as small as possible and always less than two millimeters and preferably comparable to that of microfocus tubes. Some of the tubes must be designed such that the x-rays will be emitted perpendicular or nearly perpendicular to the plane of the electron beam. The x-ray window of the tube and its surroundings must be formed close to the electron target to facilitate placing the source near the object to be x-rayed.

Phase I: Create and deliver detailed designs for x-ray tubes in the family from which any contractor skilled in tube manufacture could build the tubes. The design must be based on proven in-use x-ray tube designs. Demonstrate that the designs will meet top level requirements, preferably by building a simple prototype tube.

Phase II: Develop, construct, test and deliver several working prototype tubes that span the design specifications created in Phase I.

Potential Commercial Market: The x-ray tubes can be utilized for computed tomography applications in industrial radiography, in the medical field, and in inspection of crated items and luggage.

OSCR: The technology will provide the Army an important missing component of a computer tomography inspection system now being designed and to be used for inspection of crated supplies while in storage, prior to shipment, or upon receiving. The current process for inspection of crated items requires the crates be opened and resealed. For certain items opening, handling, and resealing can be a safety problem and can damage the items. For certain items this process must be done in a special conditioned atmosphere, etc. In most cases, the current process is much more expensive than will be with the computer tomography system being developed. Frequently, because of the inspection cost the contents of crates are not inspected at all. Using the linear x-ray tube will make it possible to inspect the contents of crates of nearly any size without opening the crates, at conveyor belt speeds, without human supervision.

TOPIC: A94-027 TITLE: Digital Howitzer Sight
Point of Contact: ARDEC

CATEGORY: Engineering Development

OBJECTIVE: Develop an integrated sighting system for self-propelled and towed howitzers consisting of an autoleveling mount, a directional and vertical reference, a digital interface for input of fire commands, and an output display for use in positioning the weapon by the gunner.

DESCRIPTION: The present fire control sights on U.S. howitzers are optical instruments that require manual leveling, manual input of fire commands, an optical reference to a collimator to determine weapon traverse, and reference to a bubble vial for weapon elevation. This manual operation requires significant operator skill to accomplish in an accurate and timely manner, and requires additional verification to preclude accidentally firing on friendly units. As the Army moves to an increasingly digitized battlefield, this present manual artillery fire control sight will be the limiting element in the requirement to conduct responsive, effective, and safe fire support. T he essential characteristics of the fire control sight to meet this requirement are:

a) Configuration as a retrofit item so that it can be applied to existing towed and self-propelled howitzers with minimal or no modification to the existing weapon. It could also be used as a part of some future artillery fire control systems.
b) The ability to automatically level the optical element of the sight by replacing the manual levelling using bubble vials of the present sight mount.
c) The optical element (panoramic telescope) should be rugged and light weight, constructed of state-of-the-art optical technology. It should also function as the direct fire sight for targets out to ranges of 2000 meters.
d) The sight should have a directional reference which will determine the orientation of the gun tube with respect to a grid north reference when the gun is initially layed upon occupation of the firing position. The required accuracy is one artillery m il with a required time to orient of 180 sec and a desired time of 120 sec. This directional reference will also function as the reference for subsequent traverse of the gun tube. The reference may be integral with the sight or a separate unit mounted elsewhere on the weapon with an electrical/electronic interface to the sight. The optical element is also to be referenced to this directional reference.
e) The sight should have an electronic horizontal reference integral to the sight. This reference would function as the reference to elevate the gun, to level the optical element, and to position the optical element for direct fire.
f) The sight should electronically accept fire commands in digital format either in standard RS-422 computer format or in the present gun display unit format.
g) The sight should output to a suitable display for the gunner, the direction and the amount to elevate or depress the gun and to traverse the gun so that the gun is pointed in accordance with the given fire commands. The optical element should also move in such a manner that the reference direction is maintained. The sight should output a digital signal which confirms tot eh source of the fire commands that the gun has been correctly positioned in elevation and traverse.
h) The sight should provide for one man, one sight aiming of the howitzer. An auxiliary display for elevation only may be required for the assistant gunner to allow for two man operation on some weapons.

Phase I: Develop a conceptual design for the digital sight including appropriate trade-off analysis to define the significant features and the specifications for the components. Do an error analysis to determine the required accuracy of the azimuth and elevation references and any other components which impact the overall performance of the sight. Develop a preliminary design for the optical element. Complete a preliminary functional specification and a plan of r development of four prototype units in Phase II.

Phase II: Develop four prototype digital sights for engineering test and field evaluation. Initial testing will consist of engineering tests in the laboratory and in the field to validate the design concepts and to verify the sight's operability during live firing. Subsequent testing will extend to a firing platoon (four guns) and will expose the digital sight to a user field evaluation. Based on the analysis of data from the tests and the demonstrated accuracy and functional characteristics, develop a finalized functional specification for the digital sight.

Potential Commercial Market: The technology developed under this program would have broad application int he ares of civil engineering, environmental and other disciplines where accurate orientation of a device with respect to external references is required. Any robotic device which must accurately position itself to perform a task while maintaining a relationship to a directional or horizontal reference would be a specific application of this technology. The commercial market potential for this technology, packaged in a different form, is extensive and would definitely support follow-on development.

OSCR: This digital sight would increase the responsiveness and accuracy, and improve the safety of existing U.S. Army howitzer weapons, both self-propelled and towed. All weapons, except those of the M109 family, converted to Paladin configuration would benefit from its development and production. It would be possible to retrofit existing weapons with minimum cost. The digital sight wold be compatible with the existing TACFIRE system and the future AFATDS and digital battlefield without modification. The system would be lighter and easier to manufacture than present optical sights and mounts and would include inherent alignment verification and backup capability lacking in other all electronic howitzer fire control systems.

TOPIC: A94-028 TITLE: Computer Aided Software Testing for Reusable Ada Software Components
Point of Contact: AC&ISD

CATEGORY: Exploratory Development

OBJECTIVE: Develop concepts and software tools that can reduce the amount of testing required on a reusable software component (from a reuse repository) when it is reused is another environment. Software reliability must be measurable in the new environment with a minimum amount of testing. The goal is to reduce the amount of testing necessary to reuse a software component in another application.

DESCRIPTION: The Army (and DOD) could benefit from an automated software testing tool for Ada components that can capture, store, and retrieve internal data state information. This information might then be used to reduce the time required in re-testing the component when reused. Like hardware, reusable software components are seen as a way of increasing software reliability. Reusable hardware components allow one to quickly replace faulty hardware. This has greatly increased the reliability and reduces the down-time of hardware systems. It is hoped that software reuse can result in similar improvements for software systems. Object-oriented languages and libraries of mathematical and scientific procedures are outgrowths of this desire to reliably reuse software. When a software component form one application can be reused reliably in another application, software development time is decreased and programmer productivity is increased. A proposed approach is to develop a technique to verify the software component by collecting information on the data states during its initial testing. By collecting this information, along with the output produced by that data state, one is able to stop the testing whenever a data state created is identical to one already collected during the initial testing. This is possible because for this test case we already know the outcome. This technique will help to reduce the development time and costs when using reusable software components.

Phase I: This phase would study various methods to efficiently capture, store, and retrieve the internal data state information to reduce the time required in re-testing the component. Measures, such as testability, would be applied to determine where, and how to best apply the techniques to software components. A final technical report would document the work and suggest appropriate implementation strategies.

Phase II: Phase II would design, prototype, and demonstrate the tool on actual Ada software components.

Phase III: This phase would validate and commercialize the prototype by experimenting on actual Ada software components in a repository and their reuse in practice. The contractor would provide evidence of the advantages of using this technique. Deliverables would minimally include the software and documentation, and final technical reports summarizing all experimental evidence collected, research findings, and an overall evaluation of this technique in terms of applicability to real world reuse activities.

Potential Commercial Market: Dual use potential is excellent. Private sector firms that are using Ada have the same need to reduce the cost of testing software. Potentially, 100% of the technology developed in this research will be pertinent to non-government agencies.

TOPIC: A94-029 Title: Video Compression Routines
Point of Contact: AC&ISD

CATEGORY: Exploratory Development

OBJECTIVE: Develop fast compression and playback routines for full screen, full motion, color video with sound.

DESCRIPTION: Army mechanics are being issued computers to help them diagnose and repair faults. The computer, called the Contact Test Set (CTS) III, is a 486 laptop running under Microsoft Windows 3.1. The Army Research Lab is working with the Ordnance School to develop diagnostic software for the M1 turbine engine. This software runs on the CTS III and will replace existing paper manuals for the engine. The need for sound and video capability has been demonstrated at recent field tests where soldiers were asked to diagnose engine problems using the CTS III.

Phase I: Survey existing standards for audio and video compression and playback are suitable for use on the CTS III. Identify potential new routines and techniques. Compression routines should handle 24 bit color video with 16 bit synchronized audio sampled at 22KHz. Playback speeds should approach 30 frames per second on the target architecture. Compression ratios should store several minutes of synchronized video and audio in 1 MB. Playback routines should be Windows 3.1 compatible. Identify any hardware upgrades associates with playback routines.

Phase II: Development of a prototype compression and playback system based on the results of Phase I. Provide estimates of compression ratios and playback speeds. Demonstrate system using Army provided samples. Provide system documentation.

Potential Commercial Market: The PC multimedia market is huge.

TOPIC: A94-030 TITLE: Comprehensive Array Design System for Printed-Circuit Antennas
Point of Contact: ARO

CATEGORY: Basic Research

OBJECTIVE: To develop computer aided design (CAD) which will be capable of one iteration design of printed antenna and antenna array systems. The purpose is to enhance the current design process and to facilitate novel design of printed antennas embedded in the complex environment uniquely found in the Army battlefield environment.

DESCRIPTION: Studies continue to show that, the radiating system of portable Army electronic systems become a dominant factor in the attainment of compact, reliable systems with optional power performance. As power requirements for digital processing electronics continues to dramatically decline, analog RF components and systems become the major user of primary battery power. Because of fundamental limitations, as expressed in the "Friis" equation, gain related to the efficient and perhaps self-adapting antenna system remains an area where system improvement can be achieved. This gain improvement impacts battery weight requirements with almost a linear factor for modern communications systems (e.g. doubling the antenna system gain will reduce the battery weight by almost a factor of two). Printed antenna are light weight, small in size, inexpensive to produce, conformal to complex surfaces and highly efficient. Despite the fact that they are easy to produce, progression realizing the full potential has been slow due to difficulties in modifying or tuning designs once they have been fabricated. Without adequate analysis / diagnostic tools, antenna designers simply cannot afford to apply these antennas in complex environments, nor can they afford to explore novel concepts. The concept of a comprehensive array design system for printed circuit antennas and arrays, including the feed network must be developed. To provide an all-encompassing design environment, the design system must have the capability to perform array synthesis, to simulate aperture as well as patch antennas in a multi-layered configuration, to design feed networks, to analyze layouts and to perform sensitivity analysis of the resulting radiating system. All of these capabilities must be integrated seamlessly int o a common design framework. To develop a comprehensive array design system involves not only the development of new simulation programs, but also a user friendly graphical interface. Most rigorous numerical programs for antennas are non-trivial because to use they require not only specifying the boundary of the geometer but also discretizing the array structure geometer into cells as well. This is especially true for sensitivity analysis where small dimensional modifications are often involved. Without a convenient, interactive interface to perform the tasks, the practical usefulness of a design is limited. A state of the art interface can provide built-in knowledge and design automation.

Phase I: To develop a graphical user interface for specifying printed antennas and arrays in a multi-layer environment. The interface must include circuit elements found in the feed network and the range of transmission media employed in the feed network a s well as the radiating element.

Phase II: Expand the user interface and electromagnetic simulator tools to include applications specific Green's function module and to provide capability to link the module with the simulation engine.

Potential Commercial Market: The technology obtained will have application to a wide variety of portable electronic systems. Antenna system efficiency and array processing will play a key role in reducing power requirements, hence, reduction of battery requirements. This effort will have direct application to the entire range of "wireless" systems now under evaluation and to systems operating on the "Information Highway."

TOPIC: A94-031 Title: Improving System Sensitivities for Army ELINT and ESM Systems
Point of Contact: CECOM

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate concepts for improving overall system sensitivities of Army ELINT and ESM systems.

DESCRIPTION: The preponderance of recent analytic and experimental signal detection development have focused on detection of the amplitude of a received signal against system noise amplitude background. Emphasis has been on methods to increase the amplitude of the received signal via a variety of approaches to make the detection process coherent relative to the carrier phase in a matched filter context. In every case, the classical radar "ideal correlation detector" cross correlates an exact replica of the transmitted pulse with the target return to accomplish coherent detection. The preoccupation with waveform coherency has limited spread spectrum and/or low probability of intercept or detection system designs to the use of either pseudo-random "noiselike" waveforms or the use of a true noise waveform plus a reference signal. the resulting waveforms have intrinsic features (e.g. spreading chip rate) that can be detected by conventional feature detectors. Systems or major military importance, such as electronic intelligence (ELINT) systems and electronic support measures (ESM), which deal with uncooperative signal detection and processing,m are generally not afforded the opportunity for ideally matched filter signal detection and often only incomplete definition of the target signal is available. The net result of these factors is a system with marginal sensitivity. Alternative analog and/or digital parameters, such as spatial processing, are sought for coherent processing of these signals.

Phase I: Investigate alternative analog/digital concepts for coherent detection and processing of ELINT and ESM signals. Parameters should include examination of angle and phase of arrival.

Phase II: Fabricate a laboratory breadboard coherent processor that can demonstrate quantitative improvement in sensitivity for an existing Army ELINT system, for example, the QuickLook system.

Phase III: Fabricate a flyable prototype processor design that can demonstrate significant improvement in QuickLook, or other ELINT/ESM coherent detection and processing functions.

Potential Commercial Market: Substantial improvement can be provided for air traffic control surveillance and control radar system operation and for other receivers requiring large signal to noise performance for target signal classification and recognition.

TOPIC: A94-032 TITLE: Dispersed Command Post Technology: Virtual Conferencing
Point of Contact: CECOM

CATEGORY: Exploratory Development

OBJECTIVE: Development of the capability to establish and conduct a virtual conference.

DESCRIPTION: For survivability, future command posts will be established and operate in a dispersed configuration. These command posts will consist of small, highly mobile elements. The commander and his staff officers will each operate from one of these elements. Face-to-face communications will be effected through the use of audio and video teleconferencing, data distribution and virtual reality. Audio, real time video, three-dimensional visualization of terrain, and images of maps, overlays, functional equipment, and participants will be combined into the virtual reality space of each commander and staff officer. The virtual reality space of each conference participant will reside in his own local computer. The commander will have complete freedom to move about the battlefield, interfacing with his subordinate commanders and staff via a virtual conference. He will have the same facilities immediately at his disposal whether he is dismounted at a forward observation post, seated in his command vehicle, or being briefed in a face-to-face session at his main command post.

Phase I: The phase I effort will focus on establishment of an architecture for the virtual conference. This architecture must be robust enough to permit rapid expansion of system capabilities as hardware and software technology improves. Initial design of significant system features will be completed and tested.

Phase II: The Phase II effort will construct a demonstration system incorporating the Phase I architecture at the level of capability then available.

Potential Commercial Market: Projects requiring cooperative performance including: Virtual Offices, Robotics Control, Telepresence, and Hazardous Material Handling.

TOPIC: A94-033 TITLE: Signal Recovery Via Wavelet De-Noising Techniques
Point of Contact: CECOM

CATEGORY: Exploratory Development

OBJECTIVE: To investigate, develop and demonstrate wavelet de-noising techniques as a robust means to recover signal features in a noisy environment.

DESCRIPTION: Current methods of signal recovery from noisy data usually rely on some means of linear smoothing to reduce the noise. These techniques have undesirable effects which include broadening and sometimes entirely masking features. The goal of this research is to derive and demonstrate efficient de-noising algorithms and techniques based on wavelet theory that preclude the undesired properties. Wavelet thresholding and wavelet shrinkage techniques have been shown to detect and preserve features that other techniques cannot, while at the same time achieving better noise suppression.

Phase I: Investigate theoretical approaches, develop and simulate methods and techniques, and document the methods and performance results in a Phase I report.

Phase II: Implement and demonstrate computationally efficient techniques on appropriate commercially available processing hardware to illustrate the operational feasibility and functionality of the algorithms.

Potential Commercial Market: This technology would have wide application in the commercial market. Any application that uses signal processing or image processing techniques on noisy data would benefit from these techniques. Some potential uses are in: the communications industry (e.g., cellular phones, receivers, modems), and the medical imaging industry.

TOPIC: A94-034 TITLE: Self Adapting Receiver
Point of Contact: CECOM

CATEGORY: Exploratory Development

OBJECTIVE: To develop an innovative receiver technology which will permit a receiver to autonomously adapt itself for optimum sensitivity to a selected signal given that a high signal to noise ratio sample of the selected signal is present for a very brief period.

DESCRIPTION: In many cases (e.g., an Electronic Support Measures (ESM), Electronic Intelligence System (ELINT)) the target signal is at a high signal to noise ratio occasionally (e.g., when the main beam of a target radar illuminates the receiver). In general, there is no a priori knowledge of the target signal, it is first recognized as such when at the high signal to noise ratio. In order to continue to receive the signal, at a very low signal to noise ratio it is necessary for the receiver to reconfigure itself into the equivalent of a matched filter. The waveforms of interest include, but are not limited to, Continuous Wave (CW), FM CW, AM CW fixed frequency pulses (including frequency hoppers, where center frequency is the only change), multi-phase coded direct sequence spread spectrum (pulse and CW), and FM modulated pulses.

Phase I: Develop approach, design prototype receiver to test candidate approaches, simulate/analyze to demonstrate proposed approach for Phase II.

Phase II: Conduct/demonstrate prototype receiver. Explore commercial/military spin offs and applications.

Potential Commercial Market: The techniques developed on this SBIR are applicable to a wide variety of systems: cellular communications over very wide geographic regions with very different protocols entertainment (e.g., car radio/TV that don't fade out), SATCOM on the move, ELINT/ESM/COMINT systems.

TOPIC: A94-035 TITLE: High Frequency Single-Site Location (SSL) Improvement
Point of Contact: CECOM

CATEGORY: Exploratory Development

OBJECTIVE: Improve High Frequency (HF) SSL accuracy by using a compact polarizationally diverse HF antenna array to develop an ionospheric model which can be updated in near-real-time.

DESCRIPTION: A compact, polarizationally diverse, HF antenna array (the "CART" antenna) will serve as the front end to a processor which separates the Ordinary and Extraordinary ("O" and "E") rays present in skywave signals. The horizontally and vertically polarized components of the signal can be processed with a resultant improvement in SSL accuracy. Intelligence and Electronic Warfare Directorate (IEWD) has already designed and built polarization diversity combiners for the CART antenna. During FY93, IEWD built and successfully demonstrated a broadband interference canceler using this antenna. Interference cancellation is achieved by steering the antenna pattern's null at the interferer. The ability to generate multiple nulls is being developed. The work proposed will leverage this technology to provide system solutions to Army HF communications and geo-location problems. A compact HF antenna array (the "CART" antenna) has been developed for IEWD by Flam and Russell, Inc., Horsham, PA. This antenna and/or ruggedized model of this antenna will be used in the course of this work.

Phase I: A theoretical analysis of the degree of separability of the O and E rays by the CART antenna will be performed. The ability of the CART antenna to measure arrival angles with sufficient accuracy to permit inverse ray tracing will be evaluated. Accuracy improvements will be assessed and compared with present system accuracies. Candidate separation techniques will be identified and simulated. They will be verified in non-real-time using signal data collected from cooperative and non-cooperative emitters.

Phase II: If Phase I is successful, the follow-on work will concentrate on the design and development of a high speed RF processor. Initial test and evaluation of the processor will be performed at IEWD facilities located at Vint Hill Farms. Additional field tests will be performed at the National Training Center, Fort Irwin, CA; and the Technology Assessment Center at Fort Huachuca, AZ. Finally, the performance of the improved locator will be compared with existing SSL technology during blind tests Phase II is expected to require a full 24 months.

Potential Commercial Market: The proven hardware and software will be available for transfer to Army systems which employ SSL techniques. The ability to measure and model the ionosphere in near-real-time will permit improved operational capability in NV IS scenarios. Transition of the technology into long haul HF communications will also be likely. This technology could find commercial applications in the long distance telecommunications arena. Knowledge of the state of the ionosphere combined with the ability to steer the antenna pattern to the optimum launch angle will provide more reliable communications. Improved SSL technology could be used to aid search-and-rescue operations. This would benefit the Merchant Marine.

TOPIC: A94-036 TITLE: Focal Plane Array for Staring Laser Radar
Point of Contact: CECOM

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate new and innovative designs of focal plane arrays for staring laser radar. Concepts developed must include process for range and intensity at every pixel of the two dimensional array.

DESCRIPTION: Military tactical and strategic target recognition from air and ground based weapon platforms are currently based on two-dimensional passive, image information. This information is not robust; it is constantly varying depending upon solar a nd weather conditions. Laser radar is a viable solution to providing robust/non-varying information to target recognition processes with the addition of a powerful third-dimension variable, range. Yet, present laser radar technologies utilizes scanners to sweep a single beam across the scene to be imaged which leads to complex, expensive, limited resolution and slow imaging systems. The new and innovative use of focal plane array (FPA) technology for staring laser radar resolves the aforementioned scanner limitations. Integrated FPA with parallel channel range and intensity processing, readout and digitization of each pixel is planned for the receiver. The transmitter will leverage laser technology advances and will be a high efficiency diode-pumped solid state device. This staring laser radar will truly be a solid state imager. The advantages of this all solid state laser radar are: reduced complexity and lower sensor production costs, resistance to shock and vibration (no moving parts), higher quality imagery (no scan artifacts and intra-frame relative pixel motion), angular resolution and scene coverage decoupled from laser pulse repetition frequency limitations (no lag angle), and the high frame rate capability. This technology is applicable to military robotic navigation and obstacle avoidance.

Phase I: Investigate new and innovative designs for FPA. Define requirements of FPA based on mission definition and laser radar system design. Perform detector, processor, and readout analysis. Modeling and analytical evaluation shall be used to predict the merits of the concepts. A baseline shall be established with detailed designs of the FPA and laser radar prepared for implementation.

Phase II: Implementation of the FPA concepts and construction of a staring laser radar system. Prototype designs of the FPA shall be evaluated in the laser radar testbed for evaluation. The prototype designs shall be optimized for producibility and cost effectiveness. Detailed design drawings and specifications shall be developed.

Potential Commercial Market: This technology would have application to the transportation industry and security industry. The development of new and innovative, cost-effective staring laser radars would provide a means for robust collision avoidance for aircraft, trains, trucks and even automobiles. Laser radar's three dimensional information makes it particular attractive to surveillance and intruder sensing.

TOPIC: A94-037 TITLE: Microlens Array Development for Staring Forward Looking Infrared (FLIR) Sensors
Point of Contact: CECOM

CATEGORY: Exploratory Development

OBJECTIVE: To develop microlens arrays to be applicable to staring FLIR focal plane arrays. Preliminary work was done by SBRC and Loral. This research is needed to incorporate this device in the designing stage of the FLIR system. This will result in a higher fill-factor and less retroreflection from the focal plane.

DESCRIPTION: Microlens arrays are needed to focus the incoming radiation of the detector elements of staring sensors. This has very important impacts on the sensor protection against laser threats. This will prevent spurious reflection from the areas other than the detector elements. Designs and fabrication techniques must be developed before the future generation systems are being fielded.

Phase I: Evaluate current microlens design and fabrication techniques, down-select feasible approaches and show the feasibility.

Phase II: Develop and fabricate a prototype suitable for a staring sensor configuration.

Potential Commercial Market: Develop US capabilities in optical technology and in particular microlens fabrication techniques which has huge impacts in optical reproduction field such as cameras, Xerox machines, and movie cameras, etc.

TOPIC: A94-038 TITLE: Dry Lithography of Closed-System Processing
Point of Contact: CECOM

CATEGORY: Basic Research

OBJECTIVE: Develop and demonstrate a lithography technology that is compatible with high-vacuum semiconductor processing equipment. This technology is intended to be used to apply, pattern, and remove stencil masks suitable for etching features with dimensions on the order of several tens of microns in epitaxial semiconductor layers without removing the wafers from a high-vacuum processing environment.

DESCRIPTION: In its most generic form, the conventional procedure for fabricating advanced opto-electronic devices in semiconductor wafers involves deposition of layers, patterning of layers, and removal of layers. Layer materials can be semiconductors, metals, feroelectrics, or oxides. For deposition, some form of evaporation is used; for removal, some form of plasma etching is used. For both of the processes, a wafer is held in a vacuum system. To delineate areas for etching, a sacrificial stencil mask is temporarily fabricated on the surface of a layer. An organic photo resist is the current material of choice for this mask. Resist is a liquid which is applied as droplets, patterned with ultraviolet radiation, and removed with organic solvents. Because resist technology is a "wet" process, a wafer must be removed from the vacuum system. As the complexity of devices increases and the range of materials is extended to include such delicate materials as mercury cadmium telluride and high-temperature superconductors, the push to abandon conventional wet lithography increases. The rationale for doing so is that the surfaces of these materials are damaged upon exposure to air or wet chemicals, and performance of devices is degraded. An alternative to conventional processing is closed system processing. This refers to a concept whereby all device fabrication steps are carried out without removing a wafer from the protective environment of a high vacuum system. Several embodiments of this concept now exist in government and industrial laboratories. Typically, they are a collection of individual vacuum modules connected by a high vacuum wafer-transfer mechanism. Molecular beam epitaxy deposition modules and plasma etching modules are particularly compatible with such an arrangement. Since layer deposition and etching are already vacuum processes, the only barrier to a full exploitation of the closed-system concept is the lack of a technique for mask fabrication in vacuum. What is needed is a dry lithography technology - processes and equipment for applying, patterning, and removing a contact mask, all of which are compatible with a high-vacuum environment.

Phase I: Demonstrate feasibility of a resist technology that is compatible with high-vacuum processing environments. On a semiconductor wafer held in a vacuum system, deposit a mask, transfer a pattern to the mask, open holes in the mask, and remove the mask.

Phase II: Demonstrate that the technology can be used in a closed-system semiconductor processing environment by integrating the process developed in Phase I with the Night Vision and Electronic Sensors Directorate (NVESD) microfactory located in Fort Belvoir, Virginia. This microfactory consists of five vacuum chambers and an interconnecting wafer-transfer module. Epitaxial layers of silicon, gallium arsenide, and mercury cadmium telluride are deposited and plasma etched in these chambers. In concert with NVESD scientists, utilize the microfactory and the dry lithography process to fabricate an array of mesas on various layers of these materials.

Potential Commercial Market: Diode lasers and high-electron- mobility transistors are now produced in gallium arsenide by molecular beam epitaxy and wet-chemical processing. It is anticipated that infrared imaging devices will soon be produced by mbe of mercury cadmium telluride and identifical wet-chemical processing. When low-dimensional structures emerge from research laboratories and enter a development phase, similar processing will be used. The manufacturing yield for these and other commercial semiconductor products would be significantly increased if a dry lithography process were to be made available.

TOPIC: A94-039 TITLE: Use of High Resolution Global Positioning Satellite Data in Automated Ground Truth
Point of Contact: CECOM

CATEGORY: Advanced Development

OBJECTIVE: Development of a stand-alone Global Positioning Satellite (GPS)-based automated ground truth system.

DESCRIPTION: One of the critical tasks in the evaluation of target acquisition skills of both humans and machines is comparison of the "believed" location of a target (as given by the human or target acquisition machine) with the "true" location of a given target. This "true" location of a target is called the ground truth for that target. However, this rather simple comparison is, in reality, very complex. One of the reasons for its complexity is the labor intensive nature of the task. this leads to errors in t he calculation of the performance probabilities. One of the methods for eliminating errors is to extensively use automation in the generation of ground truth files. The use of Global Positioning Satellite (GPS) data has been suggested as one of the promising methods of automation. The goal of ground truth automation is the creation of files with sufficient resolution of x, y, and height so that the location of a target at those coordinates can be projected to the image plane of a sensor for automated scoring . The system must work with both stationary and slowly moving ground targets (less than 20kph). Previous experience with use of commercial GPS equipment has shown that the standard configuration does not have sufficient resolution to support automated ground truthing. There are schemes for improving the resolution of GPS output. Analysis has shown that, in earth coordinates, target location must be resolved to 2 meters (x,y, and z) to be sufficient for automation. This task requires the development and demonstration of a stand-alone system that is capable of meeting the requirements for ground truth automation.

Phase I: Identify GPS equipment and data and information processing procedures adequate for producing output products of sufficient resolution to solve problem.

Phase II: Develop and demonstrate stand-alone prototype ground truth system whose output can be integrated with images.

Potential Commercial Market: In the sense of this SBIR, ground truth refers to the tracking of objects through space and time. Commercial applications that require the tracking of data through time and space using GPS could benefit from this work. For example, tracking of rail cars, truck vans, produce, taxi cabs, ambulances, police cars, etc. could benefit from this work.

TOPIC: A94-040 TITLE: Optical Links for Cryogenic Focal-Plane Array Readout
Point of Contact: CECOM

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate concepts for optical links to implement a digital interface to a cryogenic infrared focal-plane array (IR FPA).

DESCRIPTION: This topic presumes the development of an IR FPA with digital outputs; i.e., incorporation of analog-to-digital converters on the FPA. Assuming that these digital data channels exist, it is highly desirable to implement a wireless link through the dewar wall in order to: 1.) Minimize the thermal conductance to the FPA, 2.) Electrically isolate the FPA from the downstream system electronics, and 3.) Reduce the difficulty involved in replacing the dewar. In order to achieve any cooling advantage the power dissipation on the FPA per optical link must be significantly less than the heat conducted in by the wire which the optical link would replace. Also the part of the optical link resident on the FPA must have minimal thermal mass so that cool down time is not unacceptably prolonged. This part of the optical link must also operate at cryogenic temperatures. A typical data rate to be expected is 640 X 480 X 60 Hz X 12 bits/pixel, or ~200 megabits/sec.

Phase I: Investigate concepts for a digital optical link for transmitting digital video from a cryogenic FPA. The approach may be multichannel and should be capable of sustaining a total data rate of 200 Mbit/sec. Modelling and analytical evaluation shall be used to predict the success of the concepts.

Phase II: Fabricate a demonstration prototype, utilizing a dummy FPA data generator operating at 77 Kelvin, proving 100% accurate data transfer at 200 Mbit/sec. The prototype design shall be optimized for producibility and cost. Detailed design drawings and specifications shall be developed.

Potential Commercial Market: In a digital-output IR FPA this technology would have numerous commercial applications, including aid in aircraft landing/takeoff, remote tower forest fire detection, remote surveillance, etc.

TOPIC: A94-041 TITLE: Analog-to-Digital Converters on Infrared Focal Plane Arrays
Point of Contact: CECOM

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate an infrared focal plane array (IR FPA) with analog-to-digital conversion incorporated on the FPA. Concepts may include multiple analog-to-digital converters (ADC's) operating in parallel.

DESCRIPTION: Current IR FPA's generate several streams of time-multiplexed analog video output and buffer these streams to drive off-focal-plane ADC's. It has lately become possible to move the ADC'S onto the FPA, which would provide several advantages, including elimination of noise due to signal cross-coupling between analog lines running from the FPA and reduced power consumption on the FPA since low-power digital drivers would replace the analog video buffers. Also, more compact systems can be designed, with all of the analog electronics on the FPA. Concepts developed under this topic must be capable of operation at cryogenic temperatures and must be capable of being scaled down to an array consisting of 25 micron unit cells, although demonstration will only be required with an array consisting of 50 micron unit cells.

Phase I: Design a readout integrated circuit (ROIC) incorporating ADC's. Modelling and simulation shall be used to predict the success of the design, at room temperature and at 77 Kelvin. The baseline architecture shall be a 64 X 64 element array with a unit cell dimension of 50 X 50 microns, and the approach shall also be proved feasible f the unit cell dimension were to be reduced to 25 X 25 microns. It shall be assumed that a compatible array of long-wavelength IR (8 to 12 micron) detectors will be bump-bonded to the ROIC. Total power dissipation shall be less than 20 milliwatts.

Phase II: Fabricate a demonstration model of the ROIC, bunp-bond it to a (government furnished) Long Wave Length Infrared (LWIR) detector array, and test the complete FPA. The prototype design shall be optimized for producibility and cost. Detailed drawings and specifications shall be developed.

Potential Commercial Market: This technology would have application to commercial infrared and visible FPA's, particularly those applications requiring a digital image.

TOPIC: A94-042 TITLE: Compact Mid-Infrared Laser Source
Point of Contact: CECOM

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate innovative compact and efficient laser which will meet the Advanced Research Projects Agency (ARPA)/tri-service requirements for a Mid-infrared laser source.

DESCRIPTION: High repetition rate lasers emitting at several atmospheric transmission bands in the mid-infrared simultaneously are required for DoD applications such as laser radar and infrared countermeasures (IRCM). The main requirements are 2 to 5 watts per band, 10 kHz to 20 kHz (or higher) repetition rates, 25% duty factor, and tunable operation in the main atmospheric transmission bands between 2 and 5 microns. Innovative approaches are needed to achieve rugged, compact, efficient and producible laser sources which will operate in military environments.

Phase I: Demonstrate efficient operation in the laboratory at least one watt per band.

Phase II: Demonstrate a compact device which will meet the requirements as stated in the description.

Potential Commercial Market: Potential commercial applications include eyesafe laser radar for aircraft and vehicles for collision avoidance, terrain mapping, and remote environmental sensing.

TOPIC: A94-043 TITLE: Visual Programming for Ada 9X Software Applications
Point of Contact: CECOM

CATEGORY: Exploratory Development

OBJECTIVE: Determine methods and appropriate automated support that will facilitate visual programming for software applications, in particular mission-critical, using Ada 9X as the implementation language.

DESCRIPTION: Software is an essential (often the essential) component of most military and commercial systems. As these systems become more complex, software complexity increases correspondingly. This radically increases the difficulties encountered in software development and maintenance. Visual design methods offer a means for assisting developers and maintainers in "seeing" the complexity of the software program, allowing them to identify areas that need further attention to avoid major problems being encountered later in the development. Visual programming also enhances the communication required between management and the design team further increasing productivity. To be usable and effective, these methods must follow good software engineering principles, include visual design representation that is integral to the method, and ensure that the implemented code can be directly traced to the design. The Ada language revision, Ada 9X, will result in increased capabilities for the development of Army systems, in particular mission-critical. These capabilities will include, for example, facilities for real-time programming such as data synchronization with protected types, support for programming-in-the-large, and support for object-oriented programming concepts. Methods that currently exist for supporting the design of software using Ada 83 will have to be extended and adapted to incorporate all of the features proposed for Ada 9X. Methods that support Ada 9X, a standard language built on software engineering principles, and visual programming will be of the most benefit to software developers, resulting in more reliable and cost effective developments and lowering software maintenance and support costs, as well. This SBIR will address the issues associated with providing visual design methods, and associated automated support, for Ada 9X software for embedded and non-embedded applications. This may include but not be limited to: the selection of a method, based on a sound software engineering approach, that uses visual representations that correspond to the entire proposed Ada 9X language revision and approach for addressing issues such as use of domain specific software architectures and application performance considerations.

Phase I: Select a visual design method and define automated support needed for the creation of Ada 9X software for embedded and non-embedded applications. All features in the 9X version of the language must be addressed. Define approach(es) for addressing issues such as use of domain specific software architectures and application performance considerations.Additional consideration will be given for proposals that identify potential users, military and commercial, of the proposed product.

Phase II: Develop a prototype implementation that incorporates and demonstrates the approach and support proposed in Phase I.

Potential Commercial Market: The number of commercial companies using Ada for their large software projects is increasing. Using an effective visual design method that incorporates the advantages and features of Ada 9X and has automated support, will result in the more cost effective, reliable, and supportable software for a wider range of their products, and will also ensure a greater market for Ada in the future.

TOPIC: A94-044 TITLE: Management Metrics Decision System
Point of Contact: CECOM

CATEGORY: Exploratory Development

OBJECTIVE: Develop a management metrics expert rule-based decision system to assist managers in making programmatic and technical decisions concerning management metrics program implementations on software projects.

DESCRIPTION: There is a critical need to furnish high-level insight, of software life-cycle processes and products, to give managers control over project direction. This comes from smart use of software management metrics as a quantitative technique to complement other methods of monitoring and control. Managers need assistance in making decisions concerning establishing a metrics program (what measures, data items and resources are required to track risks associated with system requirements and programmatic issues); and in implementing a metrics program (menu-driven analysis and interpretation techniques; and what corrective actions are available and reasonable to apply in light of probable risk). The decision system will be used for "what if" sensitivity studies, trade-off analyses of resource requirements, and to help decide alternative courses of corrective action based on metrics reports and correlations. Flexibility is needed to accommodate existing metrics sets, and how each addresses primary manager issues an concerns.

Phase I: Demonstrate proof-of-concept and feasibility. Develop a plan of approach. Address risk and technical alternatives.

Phase II: Develop prototype of the system and provide a demonstration of its capabilities. Develop technology transfer mechanisms such as informal seminars and, hands-on tutoring including management game scenarios.

Potential Commercial Market: This automated technology is of prime interest to acquisition organizations charged with development of large, complex defense software systems. And, therefore, also of prime interest to private sector defense contractors. Consideration will be given those proposals identifying candidate beta sites, pilot projects and users, from both government and industry.

TOPIC: A94-045 TITLE: Narrow Band HF Data Networking Algorithm
Point of Contact: CECOM

CATEGORY: Exploratory Development

OBJECTIVE: Establish data routing algorithm for a network of HF transmitting sites taking into consideration propagation anomalies as well as traffic congestion.

DESCRIPTION: The HF channel characteristics have a profound effect on the performance of a communication system. The system performance can be influenced by such terms as receiver sensitivity, noise bandwidth, transmitted power levels, and antenna gain. But the midlatitude channel path is dominated by terms as propagation delays, amplitude distortions which are typically variable and unique on each path. The development of an HF data networking algorithm should consider a propagation dependent hierarchical network in which trade off are highlighted as a function of the number of nodes in the network. Emphasis should be placed on development of an algorithm which maximizes message thruput. The routing algorithm shall conform as closely as possible the existing Military Standards which address issues related to tactical and long-haul communications. The MIL-STD-188-220 document considers digital message transfer devices (DMTDs), and identifies the procedure, protocols, and parameters to be applied in specifications for DMTDs. Channel access methods are frequently documented in the literature. There is no interest in further documentation on the virtues of TDMA, CDMA, and CSMA.

Phase I: Outline candidate algorithms which address issue of narrow band HF data networking protocols. Assess the relative merits of selected candidates. Devise a test plan which would be necessary to fully judge the relative merits of each candidate. Simulation as well as on the air testing should be proposed in order to make the proper selection.

Phase II: Develop and fabricate a laboratory testbed which can be used to test candidate waveforms protocols. Channel conditions should be programmable to simulate channel conditions. Skywave networking tests should be conducted during this period.

Potential Commercial Market: This technology would have application to various DOD and the commercial communication industry. The protocol developed we insure interoperability between all users of HF communication equipment.

TOPIC: A94-046 TITLE: Efficient DC-DC Power Converters
Point of Contact: CECOM

CATEGORY: Advanced Development

OBJECTIVE: To develop DC-DC power converters with higher that 90% conversion efficiency for use in portable Military Communications Systems including SCAMP Block II.

DESCRIPTION: High efficiency DC-DC power converters will extend the life of the power source and lower the heat dissipation of the power converters, two concerns of portable electronic devices.

Phase I: Development and Brassboard.

Phase II: Further efficiency improvement and prototype.

Potential Commercial Market: This new technology will extend battery life of battery powered devices, therefore all commercial portable electronic devices (i.e. notebook PCs, cordless/cellular phones, camcorders) are potential markets for this technology.

TOPIC: A94-047 TITLE: Advanced Optics for Imaging Infrared Seekers
Point of Contact: MICOM

CATEGORY: Exploratory Development

OBJECTIVE: To investigate and develop innovative objective optics for imaging infrared seekers utilizing staring focal plane arrays (FPA) in general, and uncooled FPAs in particular.

DESCRIPTION: There has been a large investment by the DOD in both uncooled and other FPAs over the past several years. The uncooled FPA technology is very attractive from a seeker design standpoint because it does not require high pressure coolant gas and its attendant design complications. However, to achieve the seeker sensitivity required for operation in degraded weather and battlefield obscurants, the uncooled FPA must be utilized with a very fast imaging optics (low f/no.). When this requirement is coupled with the requirements for high resolution (i.e.. long focal length), the utility of the uncooled FPA is diminished for seeker applications. This is due to the fact that very limited seeker volume is available and high resolution, low f/no. optics are expensive and bulky. To increase the utility of uncooled FPAs in imaging infrared seekers for tactical missile applications, innovative optical designs are needed. Because of look angle requirements and limitations of gimbal torque motors, the optics need to be light in weight and physically short in length. The optical resolution must be very good (equal to or less than 0.25 MR) over a relatively large field of view (equal to or greater than 10 degrees). The potential for producing the optics at low cost (i.e.. amenable to advanced production techniques) must be a consideration in the design. Performance over wide spectral bandwidths is desired by the optics can be tailored for either the MWIR or LWIR if necessary to meet design objectives. A design which maximizes detector cold shield efficiency is desirable and elimination of narcissus effects is mandatory. The optics may include reflective, refractive and binary optic elements to achieve design goals. Ultimately, the design must accommodate the inclusion of a missile dome (probably hemispherical in shape) although a dome is not necessary fort this effort.

Phase I: Provide detailed analysis of at least two different conceptual designs through a preliminary design and performance prediction effort.

Phase II: Develop a detailed design and fabricate hardware for demonstration and testing to verify the conceptual design feasibility.

Potential Commercial Market: In addition to missile seeker applications, this item can be used on any infrared imaging sensor to improve the sensitivity and reduce sensor cost. This includes intrusion devices, law enforcement night viewing devices, forest fire detection devices, temperature measuring sensors, etc.

TOPIC: A94-048 TITLE: Digital Data Rate Interpolator and Modulator
Point of Contact: MICOM

CATEGORY: Exploratory Development

OBJECTIVE: Design and build a digital I/Q data (14-bit fixed point) interpolator and quadrature amplitude modulator capable of 8 MHz digital I/Q modulation on a 40 MHz digitally-synthesize carrier, using a 20 - 1 rate interpolation FIR filter. Better than 65 dB spurious suppression is required for the digital sampled output signal.

DESCRIPTION: The MICOM Advanced Simulation Center uses digital Quadrature Amplitude Modulation (QAM) to generate radar target and clutter signatures for Hardware-in-the-Loop missile simulations. Digital QAM has been adopted over other modulation techniques due to its direct utilization of computer-generated complex number data and its maintenance-free I/Q channel gain and phase matching. Future simulation requirements call for digital QAM at higher rates than can be generated using off-the-shelf DSP components. The need exists to investigate the feasibility and cost of developing a fixed-point rate interpolator IC capable of at least 1.28 billion 14x14-bit multiply-accumulate operations per second.

Phase I: Design and fully simulate an IC to meet the requirements stated above. Incorporate design features to permit integration of multiple ICs in a scalable architecture. Evaluate the design of difficulty and cost to produce the IC.

Phase II: Manufacture, test and demonstrate prototypes.

Potential Commercial Market: Applications include video rate conversion and QAM for the telecommunications and television industries. May also be used in conjunction with high performance digital frequency synthesis.

TOPIC: A94-049 TITLE: Missile System Operations Control System Technology
Point of Contact: MICOM

CATEGORY: Exploratory Development

OBJECTIVE: Development and demonstration of a missile system Operations Control System to be used for direct and indirect fire missile systems.

DESCRIPTION: Many control systems and associated technologies currently exist for direct and indirect fire missile systems. New smart missile weapon systems are in development and will replace existing systems. New methods for battlefield damage assessment, intelligence collection, firing doctrine, target acquisition, communications, and identification of friend and foe are either in development, engineering, production, or in the field army. The feasibility of integration of a high fidelity missile weapons command and control system from non-development-item (NDI) hardware and software needs to be assessed. This proposal will determine feasibility of either NDI technology or will develop portions or all the components required for Operational Control of ne w smart missile systems.

Phase I: Review all existing joint service command and control systems and technologies. Formulate and define the conceptual design of a direct and indirect fire missile system operations control and develop the functional specification to the forth level.

Phase II: Using the data developed and collected in Phase I, assess the feasibility and utility of using NDI hardware and software to fulfill the functional specifications. Determine the hardware and software technological shortfalls and changes necessary to meet the functional specifications and develop a full-up laboratory demonstration. Provide all technical specifications and data necessary for simulation and evaluation of the subject concept in a distributed simulation environment. Optimize hardware and software designs based on laboratory testing and provide complete documentation of the operations control system.

Potential Commercial Market: Law enforcement use by the counterdrug, state and local police. Potential use by commercial carriers for status, location and control of vehicles, products and personnel.

TOPIC: A94-050 TITLE: Acoustic Tracking of Remote, Up to 4 Kilometers, Moving Sources Using Multiple Microphone Array Beamforming Methods
Point of Contact: TACOM

CATEGORY: Exploratory Development

OBJECTIVE:To develop an array signal processing system for acoustic sensors based on available beamforming techniques that will estimate the direction of arrival of complex ground combat vehicle acoustic signals, provide exterior noise rejection and self- noise reduction.

DESCRIPTION: The acoustic signature measurement capability of Army ground combat vehicle can be significantly improved by using beamforming techniques to continuously measure the received signal during signature gathering encounters. An eight microphone array system with proper signal conditioning and analysis tools can measure the continuous directivity of incoming threat vehicles. This program will design and develop a real time array based beamforming system that will be targeted for combat vehicle platforms. The beamforming system that is to be developed in Phase I shall have the capability to nulling out all acoustic interference from sources such as generators, stationary vehicles, etc. This program will adapt existing software presently being used as target classifiers and apply them to the beamforming system as directivity measurement tools.

Phase I: The program will provide a developed plan of the necessary hardware required to perform the task. The program is to provide specifications and purchase off the shelf required components essential for operation of the signal measurement system, such as anti-aliasing filters, analog to digital convertors, digital signal processors, etc. The program will also provide specifications, and purchase, a rugged portable host computer with 20 MB memory and 200 MB disk. This phase will develop the high resolution beam forming based acoustic directivity system and be able to determine the directivity of ground vehicles for distances up to 2.5 km from the array. It is expected that the bearing estimator is to consist of 12-24 beams with a bearing estimation accuracy of 2 - 3 degrees. This phase will provide a real time operational software based system that has feature extraction and classification capabilities, including FFT spectral analysis display, test situation display and developed database acquisition capability. The developed system shall operate in C using the Unix Operating System. The contractor is to deliver a ruggedized eight microphone array whose geometry can be resolved from linear, circular and elliptical shapes. This phase will also deliver the complete operational system based on a ruggedized portable computer. All source code required for operation of the signal measurement array system will be the property of the U.S. government and will be controlled by TACOM. Training for TACOM personnel in the operational use of the measurement system will be provided in this phase.

Phase II: The beamforming measurement system is to be developed further by improving the analysis tools, algorithms and internal data bases. The developed system is to be field tested during a demonstration of selected targets.

Potential Commercial Market: The beamforming system will be able to track airport ground traffic at commercial airports. The present system in use at commercial airports is out of date and the developed system could serve as the basis of updating the system.

TOPIC: A94-051 TITLE: Applications of Radar Imaging to High Altitude Measurements
Point of Contact: TECOM

CATEGORY: Exploratory Development

OBJECTIVE: Adapt radar imaging technology to test center measurement requirements such as attitude of missiles and aircraft, miss distance between interceptor and target, detection of deployed objects, and determination of extent of damage to targets, all at high altitudes or long ranges.

DESCRIPTION: The U.S. Army White Sands Missile Range has developed measurement and processing techniques for extracting more and better information from coherent radar signals. Improved measurements include trajectory parameters, motion about the center of mass (e.g. spin and coning) and characteristics of events (e.g. time of occurrence and duration). Recent advances in radar imaging suggest it is now possible to adapt imaging technology to obtain even more information in the test center environment. Of particular interest are measurements of attitude of missiles and aircraft, measurements of miss distances of high-altitude missile and target engagements, detection of deployed objects, and determination of extent of damage (i.e, damage/kill assessment). In general, the requirement is to make measurements at high altitudes or long ranges where optical data are not available and where current instrumentation radars are incapable of making the measurements to the desired accuracy (e.g. miss distance to +/- 1 ft) or making the measurements at all (e.g. damage assessment).

Phase I: Research is required to determine the extent to which radar imaging technology is applicable to those measurements, to characterize the problems to be solved (e.g. resolution of individual scattering centers, elimination of acceleration smearing, stabilization of shifting phase centers, and identification and correction of multiple-bounce returns), and to specify the upgrades needed for the WSMR instrumentation radars and data processing facilities.

Phase II: Develop a prototype processor to make the radar images and extract the desired measurements. Some human intervention may be needed in the measurement process, but the prototype system should be as autonomous as possible, particularly in the arduous task of deriving the radar image from the coherent video data. Although the system will be designed for making measurements at long ranges, it should also work at the shorter ranges employed in many of the tests conducted at WSMR.

Potential Commercial Market: Development of this technology could expand radar applications for numerous commercial uses.

TOPIC: A94-052 TITLE: Rapid Mapping
Point of Contact: TEC

CATEGORY: Exploratory Development

OBJECTIVE: Achieve classification and feature extraction for data having digital terrain elevations (DTE) with post spacings of ten meters of less and corresponding fine resolution SAR imagery generated from interferometric synthetic aperture radar data. Pixels are to be automatically allocated to one of a number of categories such as trees, grass, water, or built-up areas, boundaries are to be defined between these categories. In addition, automated extraction of man-made features such as roads, bridges, airports, and perhaps buildings is desired as are delineation of naturally occurring features such as elevation contours and drainage patterns.

DESCRIPTION: Recent advances in synthetic aperture radar (SAR) technology, in particular interferometric SAR (IF SAR), the advent of the Global Positioning System and high throughput computing offer the potential for generating digital DTE and imagery wit h fine resolution and high elevation accuracy. This offers the possibility of the rapid generation of map products for the support of military operations as well as civilian applications.

Phase I: Demonstrate the potential for classification and feature extraction using IF SAR data using automated computer technology consisting of either conventional computer vision routines or neural nets or combinations of both. Assess the accuracy of t he performance of these algorithms.

Phase II: Extend algorithm development to address problems known to be likely in the data, such as shadows (no data) and variations due to terrain categories ranging from heavily forested to desert. Assess changes in algorithms and their expected performance for a variety of environments.

Potential Commercial Market: Automated mapping, and particularly automated generation of DTE, is highly relevant to many civilian applications such as replacement of optical technology for conventional map generation and for special purpose applications such as geological exploration, surveys for construction such as roadways or rail lines, and environmental assessments.

TOPIC: A94-053 TITLE: Antenna Monopulse Measurement Modeling and Calibration for Improved Tracking
Point of Contact: SDC

CATEGORY: Exploratory Development

OBJECTIVE: Develop a method and algorithms for calibrating antenna monopulse measurements to permit accurate off-axis tracking of depolarizing targets

DESCRIPTION: With the increased desire for Multiple Target Tracking, there is a need to accurately calibrate monopulse antenna traverse-elevation surfaces to permit accurate tracking of targets off-boresight targets unless corrected. The ALTAIR Radar at the Kwajalein Missile Range (KMR) does not presently correct for these errors. Since the typical 15 minute permission checkout is not adequate for full calibration, it is desired to have an extensive parameterized model that can be updated with the limited p remission checkout data.

Phase I: Investigate the feasibility of quickly updating the model with a small number of adjustable parameters to achieve the angle measurement accuracy requirement. Define, analyze, and evaluate potential monopulse models and associated calibration procedures suitable for permission measurement and computation. Include accuracy estimates as a function of polarization ratio and angle-of-boresight, and select one approach for implementation based on expected accuracy. Provide cost/schedule estimates.

Phase II: For the selected approach, develop a detailed calibration procedure and the software algorithms to process the calibration measurements. Develop software for real-time measurement correction based on the calibration model, and assist in integrating and performance testing the software.

Potential Commercial Market: This study is innovative in its application to allow multiple target tracking within the beam. Phase II proposals should also include an assessment of the commercial applications and markets for use of the models and procedures for calibrating and correcting monopulse angle measurements.

TOPIC: A94-054 TITLE: Data Compression for Real-Time Data Recording
Point of Contact: SDC

CATEGORY: Exploratory Development

OBJECTIVE: Design and build a data compression system for direct digital output to allow recording on standard Small Computer System Interface (SCSI) disks.

DESCRIPTION: There is a current need for a direct digital recording system for digital output form the ALTAIR Radar at Kwajalein Missile Range (KMR). At present, eight channels at two frequencies produce 320 MBytes per second of digital output data. Additional non-commercial markets include NASA ionospheric data collection, other Spacetrack radar sites, and scientific data collection.

Phase I: Investigate the performance of data compression algorithms against test radar data from Near Earth targets. Determine the best compression method and data recording media requirements. Project requirements towards available common disk drives.

Phase II: Construct the data compression system. Integrate with commercial, off-the-shelf (COTS) disk drives, and test in the ALTAIR system. Verify recording performance against the present recording system.

Potential Commercial Market: Applications include hi-volume weather, geologic, astronomic, etc., data recording. Phase II proposals should also include an assessment of the commercial applications and markets for use of the data compression system with the FAA air traffic control system and ship traffic radar control systems.

TOPIC: A94-055 TITLE: Acoustical Detection of Arcing in High Power Wave Guides
Point of Contact: SDC

CATEGORY: Basic Research

OBJECTIVE: Develop a method to determine the location of an arc in high power waveguides to allow repair without dismantling a large portion of the waveguide.

DESCRIPTION: When high-power waveguides are installed in corrosive environments, the joints in the waveguide often deteriorate and gaps develop that lead to arcing and then to dangerously high Voltage Standing Wave Ratios (VSWRs) in the waveguide. Since the arc produces an acoustical shock wave, like mini-lighting, microphones can detect the arc and time-to-detection can be used to determine the arc position. A technique using microphones at intervals based upon attenuation along the waveguide, and a time-of-arc based on the start of a pulse or VSWR, could be used.

Phase I: Design, analyze, and build a prototype acoustical detector.

Phase II: Construct and demonstrate the acoustical detector.

Potential Commercial Market: High Power microwave system manufactures and high voltage equipment users are potential users. With some modifications, other acoustical fault detection devices can be developed. Phase II proposals should also include an assessment of the commercial applications and markets for use of the detector.

TOPIC: A94-056 TITLE: Data Fusion for Enhanced Deep Space Surveillance
Point of Contact: SDC

CATEGORY: Exploratory Development

OBJECTIVE: Fuse optical and radar data by creating a hybrid state vector consisting of optical angles and radar range/range-rate, for tracks of deep space objects.

DESCRIPTION: Catalog maintenance for deep space satellites could be significantly improved if the radar angles are replaced by optical measurements from an optical sensor. The Kwajalein Missile Range (KMR) ALTAIR radar is located near various optical sensors and is one system that could provide increased accuracy deep space surveillance data by fusing optical and radar data.

Phase I: Determine the benefits to fusing the optical and range/range-rate radar data and specify the necessary upgrades to the optical sensor to allow joint space surveillance operations.

Phase II: Procure commercial, off-the-shelf (COTS) equipment for the optical upgrade and integrate the optical and radar systems to create the new hybrid radar/optical sensor.

Potential Commercial Market: A hybrid radar/optical sensor using COTS equipment is desirable at many RADAR locations where increased accuracy is necessary. Phase II proposals should also include an assessment of the commercial applications and markets.

A-4 HIGH PERFORMANCE COMPUTING, COMMUNICATIONS, NETWORKING AND SIMULATION (I.E. MODELING DISPLAYS, AI, VIRTUAL REALITY)

TOPIC: A94-057 TITLE: Software Infrastructure Technology For Smart Weapon Applications
Point of Contact: ARDEC

CATEGORY: Exploratory Development

OBJECTIVE: Develop design, analysis and prototyping tools and technology to support specification, implementation and evaluation of standard software reference architectures and application components for distributed smart weapon applications.

DESCRIPTION: Embedded software will be a key cost driver in next generation smart and brilliant weapon systems due to increased computational and software complexity, stringent hard real time computational constraints, and the high cost associated with software testing, verification, validation, and software maintenance and support. A key enabling technology for managing and controlling software cost and complexity is the development of standardized reference architectures and supporting infrastructure technology, tools a nd design methodology. Progress to date includes the development of an architecture schema and architecture description language which provides a formal mechanism for describing architecture components and interconnections, together with preliminary repository tool s for storing, manipulating and visualizing schema data. Further extensions of this technology is required, however, to provide complete end-to- end software development support for distributed intelligent weapon launcher applications. Specific requirements exist for:

(1) domain modeling and analysis tools and methodology which are tailored for extracting reference architecture requirements;

(2) architecture description languages that provide sufficient expressive power to represent component functionality, component interface connections, control and data communication paradigms, etc. and support detailed analysis of architecture behavior/performance;

(3) a repository tool with graphical user interface that supports storage, manipulation, browsing and retrieval of application architecture descriptions and components and the composing of new application systems from existing or re-engineered components;

(4) development of reference architecture specifications for conventional smart weapon launcher systems that facilitates reuse of components within the application domain (e.g. smart mines, smart mortars, intelligent artillery crew associates, etc.);

(5) development of generic architecture/application components that conform to reference architecture specifications to include real time data base management, real time, intelligent multi-processor/ multi-tasking os, MMI, digital mapping, real time planning, resource management/allocation, hybrid systems control, etc.;

(6) application generators; and

(7) metrics for determining conformance of application architectures to reference architecture specifications.

Phase I: Assess maturity and capability of existing tool environments to support an end-to-end architecture based software development process for distributed intelligent weapon launcher applications. Develop preliminary requirements for an integrated tool environment that fully supports an architecture driven software development process.

Phase II: Develop tools and supporting design methodology for executing, as a minimum, critical process threads associated with (a) reference architecture extraction from domain models, (b) representation, analysis and archiving of application architecture descriptions, (c) requirements tracking, (d) application generation based on composing reusable/re-engineered components, from component repositories, with possibly new components produced via component generators. Demonstrate and validate technology by populating a baseline component repository and composing a laboratory application prototype.

Potential Commercial Market: This topic will provide enabling technology that is applicable to the development of all large scale, distributed, real time software systems such as those associated with factory automation, command and control, health services, banking, environmental monitoring, communication networks, etc.

OSCR: This technology will provide significant cost reductions in operation, maintenance and support costs for embedded software systems associated with next generation automated crew stations, smart mines, smart mortars, brilliant munitions, by supporting software component standardization, reuse and customization and enhancing overall system reliability and fault tolerance.

TOPIC: A94-058 TITLE: Fire Control Battle Management and Decision Support System Technology
Point of Contact: ARDEC

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate advanced software and expert system decision aids technology for direct, indirect fire and smart mine field control. Develop embedded training for using the expert system decision aids for direct/indirect fire and smart mine field control applications.

DESCRIPTION: The feasibility of developing high performance expert system decision aids for direct and indirect fire systems and smart mine applications has been demonstrated recently based on laboratory prototype tests. Further technology development i s required, however, to address specific algorithmic issues associated with real time planning/replanning, sensor/information fusion, terrain analysis, as well as issues of knowledge engineering, man/machine interface, rapid prototyping and simulation environments for evaluating decision aids. Expert system decision aids which address one or more of the following requirements are of specific interest: (a) Identification Friend or Foe (IFF); (b) Fire Control (acquisition/tracking); (c) tactical planning/order preparation; (d) tactical situation assessment; (e) status/reports; (f) self defense of weapon platform; (g) sustainment; (h) command and control (C2); (i) fire direction; (j) communication; (k) reconnaissance, selection and occupation of position; and (l) embedded training.

Phase I: Develop methodology for design and implementation of distributed expert system decision aids for direct/indirect fire and/or smart mine field control applications. Formulate and define conceptual designs for specific expert system modules including hardware implementation and software prototyping environment. Develop detailed functional specifications.

Phase II: Develop a full-up laboratory technology demonstration prototype decision support system with appropriate displays, simulation driven, development environment and run-time environment. Develop component-based software architecture and tool environment which will support reuse and re-engineering of software components thereby reducing overall software development and maintenance cost of embedded decision support systems. Optimize hardware/software, algorithm and interface design based on laboratory test results and provide complete documentation of hardware/software, analysis and test results.

Potential Commercial Market: Developed technology has potential for commercial wargame products. In addition, required algorithm development in real time planning/replanning, sensor fusion, and terrain analysis can be used in commercial development of decision aids. Embedded training algorithms can be used on a wide variety of commercial software package offering.

OSCR: Developed component based software architecture and tool environment will support reuse and re-engineering of software components, thereby reducing overall software development and maintenance cost of embedded decision support system. Embedded training will reduce training cost on using expert system decision aids for control applications.

TOPIC: A94-059 TITLE: Neural Network Limit Avoidance System for Rotorcraft
Point of Contact: AVRDEC

CATEGORY: Exploratory Development

OBJECTIVE: Develop a system that can accurately detect the onset of aircraft limit exceedances and take action to avoid them.

DESCRIPTION: Helicopters typically contain complicated limit envelopes which are difficult to predict and poorly annunciated to the pilot. The Army is currently conducting research in the area of envelope limitations and has identified a number of critical limits which generally occur in all helicopters. One needs to be able to sense the onset and then automatically avoid these limits, to protect the pilot and aircraft from loss of control, to avoid catastrophic failure, to reduce the number of minor exceedances that degrade airframe fatigue life, and to permit the pilot to safely fly the aircraft close to the edge of the envelope. A primary strength of neural networks is their ability to perform rapid pattern recognition. Given the proper training data, a neural network could be developed that rapidly identifies the onset of limit exceedances based on the pattern presented by aircraft control positions and rates and aircraft body states. Once the limit exceedance information is made available by the neural network, a feedback algorithm could be developed which takes the necessary corrective action to avoid the exceedance.

Phase I: Review theory on helicopter limit exceedances and available databases. Develop a proposal to show how this information could be used to train a neural network for exceedance detection.

Phase II: Develop a neural network that will perform limit exceedance prediction and train it using available test data. Install this network in a high-fidelity Army research simulator and demonstrate its ability to perform limit detection in a real-time environment.

Phase III: Review fuzzy logic theory to determine its potential for forming the basis of a control feedback limit protection scheme. Develop a proposal to show how a fuzzy logic protection algorithm could be implemented. Develop a fuzzy logic limit protection algorithm and demonstrate its capabilities. Install the algorithm in a high-fidelity Army research simulator and demonstrate its ability to protect a helicopter from limit exceedances in a real-time environment.

Potential Commercial Market: With the rapid increase in on-board computational power and replacement of current-day control rigging with automatic fly-by-wire control systems, the achievement of automatic envelope protection becomes practical. The increased safety, extended operational envelope and reduced maintenance requirements that are possible with such a system means that the first company (or country) to bring such a system to market will enjoy a distinct advantage over the rest of the helicopter manufacturing world.

TOPIC: A94-060 TITLE: Visual Programming Language Development
Point of Contact: MICOM

CATEGORY: Exploratory Development

OBJECTIVE: The objective of this activity is to extend the concept of object oriented programming to a visual programming paradigm where each software object is an icon with standardized inputs and outputs. Although this has been done in the commercial world in a few narrow applications areas, the application of this concept to software in general has not occurred. The objectives of this task are to begin to formulate standards within DoD which will encourage development of the visual programming paradigm for software in general.

DESCRIPTION: Object oriented programming and software reuse are two DoD initiatives which promise to hold down the rising cost of software development and maintenance. However, neither of these two initiatives address the critical problem of sheer numbers of lines of code nor the problem of standard software interfaces. For example, even a moderately complex system such as the MLRS Improved Fire Control System is expected to contain over 150,000 line of code, and no standard software interfaces have been described for its software modules. These problems are systemic. They exist because the basic element for software definition is the "line of code". Such problems can be addressed in a manner similar to the methods used by engineers designing with integrated circuit s; i.e. circuit details at the transistor level are abstracted away into a functional blocks. Each functional block is represented on the schematic by a rectangle with standardized input and output pins and a defined function. These blocks are then wired together to form the data paths between blocks. Functional blocks can be combined using hierarchical design techniques to form higher level functional entities such as circuit cards or "black boxes". Such a methodology, if applied to software, would greatly simplify the task of designing, implementing, and maintaining software by abstracting away actual code lines into functional blocks. These blocks would have defined (standardized) inputs and outputs and could easily be maintained in a library for reuse. As a side benefit, software testing tools would be easier to develop because of the standard interfaces. By using such techniques, software productivity could be increased by at least an order of magnitude. Current software products are available which implement these concepts for narrow application areas (such as signal processing). The purpose of this SBIR topic is to extend these concepts to broader applications, to begin development of a standard tool base, and to begin developing DoD standards for the visual programming concept.

Phase I: This phase would begin the primary studies required for the development of a visual language and its associated programming environment. In this phase, the contractor would make an extensive study of existing visual languages, determining their strengths and weaknesses as to application to a general programming environment. The contractor would also investigate ongoing research into visual programming languages and environments and visual language grammars. Based on these investigations, the contractor would make recommendations on such topics as execution paradigms (an example of which is data flow graphs and Petri nets, where a task is instantiated but cannot execute until all of its inputs are available), task-to-task interfaces, visual programming paradigms (for example, would directed graphs or some other method be used to describe a program?), and first-level programming primitives. As part of this phase, the contractor would also give proposals for a complete visual programming system.

Phase II: The second phase of the work consists of a number of subphases, each of which builds on the preceding efforts and are successively more complex. What is ultimately desired as a programming environment in which general-purpose, real-time programs can be developed and maintained as well as a standard way in which software modules can be added to this environment. These subphases would be:

1. Development and documentation of a standard task-to-task interface whereby a software developer can construct executable tasks to run under the visual programming environment.

2. Development of a visual programming environment, in which the user can develop, debug, and execute programs by graphically linking in individually compiled tasks. As part of this environment, there would be some set of "primitive" general-purpose tasks from which the user could reasonably be expected to construct more complex tasks. Once an application has constructed and debugged, the environment would allow the user to produce a stand-alone executable, not requiring the development environment for its execution.

3. Development of a more extensive library of primitives and "compound primitives," that is, tasks created from other primitives. This would allow the development of hierarchical programs as well as reuse library based on specific programming tasks.

4. Because it is desired that this environment be utilized for the development of real-time programs, the requirement for handling of interrupts must be addressed. The contractor will have to address such problems as what is the appropriate size for an "atomic," that is, non-interruptable, operation. The contractor may also have to develop primitives for the synchronization of independent streams of execution. The contractor will have to develop graphical methods for enabling and disabling interrupts, or provide some abstraction which accounts for this.

5. Once the subject of atomic operations is addressed, the contractor will then have to investigate the timing of primitives. This will allow the user to make reasonably accurate assessments of total program execution time. It will also allow the simulation of real-time software systems in non-real-time environments. As these investigations are performed, the contractor can construct tables of execution tie versus memory versus platform for each of the primitives. These tables could then be included in the programming environment, allowing the programmer to select the size and speed of primitive to match the application. This would also allow the development of standardized, reasonable benchmarks by which different hardware/software systems could be compared.

Potential Commercial Market: The potential commercial market is very large. Commercial interests face the same problems as DoD when it comes to software: specifically, high development costs and even higher maintenance costs. The end product of this effort will provide commercial user and the DoD user with a means of controlling, and even significantly reducing, these costs. Also, by its nature, this visual environment should significantly ease the effort in transporting a program from one type of execution platform to another.

TOPIC: A94-061 TITLE: Sensor Fusion Implementation with Neural Networks and/or Fuzzy Logic
Point of Contact: MICOM

CATEGORY: Basic Research

OBJECTIVE: Since: 1. Sensor Fusion is multiple, parallel, temporal, and spatial by nature; and 2. many of the elements within Sensor Fusion (e.g., association, classification, correlation, assessment, etc.) are tasks readily performed by neural network (s) and/or fuzzy logic; Sensor Fusion is a field that should be examined for potential improvement(s) by the utilization of Neural Network/Fuzzy Logic (NN/FL) implementation.

DESCRIPTION: Sensor Fusion, a fundamental part of the sensor/processor system can be defined as the merging of data from multiple sensor sources separated by time, location, spectral band, field of perspective, etc. Critical issues include the integration of multiple sensors performing multiple functions of acquisition, tracking, and weapons fire control. There is a need for a variety of sensors, offering a qualitative evaluation of sensor capabilities versus mission requirements. In many scenarios, no sensor may detect every target present but with sensor data fusion, all sensors can jointly contribute to all the targets detection, recognition, and identification. Sensor defects, distortions, and misalignments may be detected and corrected for using fuzzy logic. Other advantages of using NN/FL in Sensor Fusion are: robust operational performance, increased confidence, the ability to handle imprecise data and noise, reduced ambiguity, enhanced spatial resolution, improved system reliability, and increased dimensionality. A "cookbook" of sensor types (e.g., EO/IR, TV, RADAR, Identification-Friend or Foe (IFF), etc.) shall be assembled with their performance characteristics, including any NN/FL techniques required for each sensor's integration and implementation within the Sensor Fusion System. An interactive, user-friendly, query type system shall be provided for adding "additional sensors" and their performance characteristics [including the necessary NN/FL implementation and integration technique(s)] to this data base.

Phase I: Research, develop, and design a sensor types "cookbook" data base containing each sensor's performance characteristics (including sensor defects, distortions, and misalignments). Examine, evaluate, and include in this design, each sensor and its potential for NN/FL implementation and integration within the Sensor Fusion System (SFS), listing its NN/FL characteristics (as identified in the Description:, above). Include all of this data in the Phase I Report.

Phase II: Implement the design of Phase I:, (on a VAX/VMS), such that two SFSs (one conventional and one using NN/FL implementation) can be "built" using a variety of sensor(s) selected from the sensor types "cookbook" data base and/or a variety of sensor from the "additional sensors" data base. Sensor performance data, error analysis data, and NN/FL SFs performance data vs. conventional SFS performance data (for the resulting SFSs) shall be either displayed or printed.

Potential Commercial Market: Multi-Sensor Avionic Systems, Multiple RADAR(s) System, Multi-Sensor Control Systems, Multi-Sensor Identification & Recognition Systems, Multi-Sensor Surveillance and Reconnaissance Systems, Multi-Sensor Robotic Systems, Multi-Sensor Pollution and Environmental Monitoring Systems, and Multi-Sensor Diagnostic Systems.

TOPIC: A94-062 TITLE: Locomotion Simulator for Dismounted Troop
Point of Contact: STRICOM

CATEGORY: Exploratory Development

OBJECTIVE: To develop a system that will accurately simulate locomotion through a virtual reality environment.

DESCRIPTION: Ideally, the locomotion simulator will allow a trainee, immersed in a virtual reality environment, to move through the virtual world and across virtual terrain permitting the trainee to walk, run, crawl, and climb as might be required in a combat situation. This simulated locomotion of the trainee should take place without actual translational motion within the fixed reference frame. Yet the simulator would allow the trainee to expend the same energy in the simulator that would result form movement through the real world. The simulator will provide the appropriate "equal and opposite reaction" forces to the trainee to support his perception of locomotion in the immersive virtual environment. Standard treadmills and/or stair-steppers, as used in gymnasiums and health care facilities constrain motion to the extent that the immersive experience would be compromised.

Phase I: Formulate feasible system concept.

Phase II: Develop and demonstrate feasible prototype system.

Potential Commercial Market: This system has commercial applications in all forms of training involving locomotion (i.e. firefighting, police, football, etc). This technology would augment video games and theme park rides and provide realistic motion platforms for conducting physical rehabilitation.

TOPIC: A94-063 TITLE: Virtual Test Range (VTR)
Point of Contact: STRICOM

CATEGORY: Basic Research

OBJECTIVE: Develop a VTR environment, to conduct virtual reality based testing of real and virtual equipment.

DESCRIPTION: It is very expensive and sometimes hazardous to test and qualify military equipment, components and systems. Virtual reality offers some intriguing possibilities to short cut the repetitive development and test process. The VTR will provide and environment and tools to interact with real or virtual prototype systems within the context of system development, and developmental and operational testing. The VTR would allow a developer to test real and virtual breadboards under selected test conditions. System testers will utilize the VTR to definitive test procedures and plans prior to the start of testing and for verification/validation of data both during testing and after testing completed.

Phase I: Develop concept and demonstrate feasibility.

Phase II: Develop and demonstrate prototype system.

Potential Commercial Market: The VTR concept would be applicable to all equipment developer who build and test new design concepts.

TOPIC: A94-064 TITLE: Analytical Tools, Effectiveness Models and Interactive Simulations for Ground Vehicle Design Optimization and Virtual Prototyping
Point of Contact: TACOM

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate innovative and efficient computer models to supplement TARDEC Virtual Prototyping (VP) process.

DESCRIPTION: The VP is a process by which advanced computer simulation enables early evaluation of new vehicle concepts without actually building a physical vehicle. Process lends itself to continuous military user participation which will result in a high degree of user/developer agreement prior to actual building of the hardware system. The steps in the process are as follow:

Step 1: Concepts - Inputs to the concepting process are based on requirements from the user community via the Battle Labs and directorates for Concept Development (DCDs), advanced technologies coming out of the ARL and industry state-of-the-art components. The process starts by developing solid models of alternative concepts such as external versus turreted weapons, tracks versus wheels, etc., to meet the requirements, from which 2D or 3D drawings (solid model) can be produced in a Computer Aided Design (CAD) station.

Step 2: Performance Modeling - Analytical models can be applied to the solid model to evaluate mobility, vehicle dynamics, track & suspension, survivability, vulnerability, stealth, and lethality. Analytical results are reflected in changes to the solid model to optimize the design through an iterative process. Conflicting requirements require trade-offs which can be done in conjunction with the user.

Step 3: Wargame Modeling - Resulting concept vehicles are next evaluated using wargame models. Initial concept effectiveness screening is done using GROUNDWARS. This is followed by detailed concept effectiveness screening using CASTFOREM.

Step 4: Virtual Mockup/Detailed Design - The selected concept proceeds to a detailed design phase in which the solid model is refined to incorporate actual components, concurrent engineering and logistics support factors in the design. A 3D VP is developed in which the user can actually explore the inside of the vehicle.

Step 5: virtual Factory - concurrent engineering relative to the actual manufacturing processes is provided in parallel with the detailed design phase. The machine tool paths, production line set-up and timing of materials, machining processes and assembly lines for production of parts and the assembly of the whole vehicle system can be laid out and tested prior to the actual implementation on the factory floor. This results in significant time savings and reduction of scrap material.

Step 6: Crew Station Development - The virtual mockup results in a crew station envelope which is used to establish the crew station design using the soldier-in-the-loop crew station simulator under static and dynamic conditions. The crew station simulator is connected to the Distributed Simulation Internet (DSI) to enable a seamless battlefield simulation using remotely located manned simulators to enable the battle labs to evaluate effect of the concept design on tactics and force effectiveness.

Phase I: Develop/adapt computer models that support or perform one or more of the functions described in the VP steps 2 & 3 described above for combat vehicles.

Phase II: Develop an automated transfer of information within and/or between the steps described above.

Potential Commercial Market: Many of the models will have application in design development within the commercial sector.

TOPIC: A94-065 TITLE: Real-time Vehicle Attitude Estimation System
Point of Contact: TECOM

CATEGORY: Engineering Development

OBJECTIVE: To develop that will produce real-time vehicle attitude estimates by matching object outlines with video image outlines.

DESCRIPTION: White Sands Missile Range tracks missiles, aircraft and submunitions for the purpose of performance evaluation. Optical Tracking Systems that use video as a recording medium are used for this purpose. Objects tracked may have velocities as high as 5000 ft/sec, and video data is generated using 60 non-interlaced fields per second. The attitude (pitch, yaw and roll) of the object being tracked can be estimated be matching the outline of the video image with a catalog of prestored outlines. At least two views of the object from different tracking locations are required to perform this estimation. The quality of the estimation derived is dependent on the video image quality, the number of observing instruments and the accuracy of the catalog of observed images. Real-time implementation of this method of vehicle attitude estimation is required. Systems that accomplish this estimation task using commercial off the shelf hardware and software are preferred. A 60 per second update rate is required. Maximum acceptable system latency is less than 100 milliseconds. Vehicle attitude estimates produced by this system will be used to produce three dimensional graphical presentation of test item performance. High end graphics work stations will be used for these presentations.

Phase I: Develop the system concept for a Vehicle Real-time Attitude Estimation System. Identify candidate commercial hardware and software that can be used to accomplish this function. Demonstrate that the approach chosen will produce real-time vehicle attitude estimates.

Phase II: Design, fabricate, test and demonstrate a Real-time Vehicle Attitude Estimation System. The system must be produced and demonstrated using real test range data. Accuracy and reliability as a function of video image quality must be verified experimentally as a part of the system demonstration. Producability for Phase III applications is also required as a part of the system demonstration.

Potential Commercial Market: Real-time processing capabilities developed by this effort would be of value to various applications of modeling and simulation, especially with regard to virtual reality simulations.

TOPIC: A94-066 TITLE: Image Processing Using Temporal Cellular Neural Networks
Point of Contact: TECOM

CATEGORY: Exploratory Development

OBJECTIVE: Produce a commercial charge coupled device (CCD) camera based on temporal cellular neural networks.

DESCRIPTION: The U.S. Army White Sands Missile Range has been following advanced in the field of neural networks for application in range instrumentation. Previously, these advanced had been confined to artificial neural networks, i.e.simulations of neural networks on conventional computers. Recently, advances have been made which may make it possible to field actual neural network technology for range instrumentation. Demonstration of this technology would require interfacing existing CCD sensors directly with temporal cellular neural networks and creating a CCD/neural network camera where signals can be processed by the neural network in a parallel and continuous manner.

Phase I: Research will be required to study and develop the design of such a camera. Because of the parallel nature of neural networks, an advanced design of how such a camera is interfaced to conventional processors and/or alternative neural network processors for further processing of the sensor data will have to be incorporated.

Phase II: Phase I design and development will lead to the implementation of a prototype version of the CCD/neural network camera. Testing of the camera will require novel techniques and use of available instrumentation.

Potential Commercial Market: True CCD/neural network cameras offer potential breakthroughs in commercial video technology in several areas: first, the standard NTSC signal would no longer be a time constraint for syncing to the video picture; second, the neural network eliminates the need for digitizing a video picture (a significant time savings); finally, neural networks would allow processing to be accomplished continuously so that pattern recognition algorithms could be processed in a fraction of the time it would ta ke conventional processors.

A-5 ADVANCED PROPULSION TECHNOLOGIES (I.E. MOBILITY AND LETHALITY)

TOPIC: A94-067 TITLE: Bottoming Cycle for Intercooled Gas Turbine Engines
Point of Contact: VPD

CATEGORY: Exploratory Development

OBJECTIVE: Develop an Effective Bottoming Cycle for Intercooled Gas Turbine Engines

DESCRIPTION: Intercooled gas turbine engines are finding increased application due to their excellent power density attributes. Intercooling, however, requires the rejection of heat which is a net loss to overall system efficiency. An effective bottoming cycle can significantly increase the specific power and fuel efficiency of any gas turbine. While bottoming cycles have been explored for extracting heat only from the gas turbine engine exhaust, they have generally been heavy, bulky, and complex. Little effort has been directed at using the rejected heat from the intercooler itself, or in combination with the exhaust heat. Innovative methods/concepts (using the Rankine cycle) are sought to produce an effective, compact bottoming cycle for intercooled gas turbines. Focus shall be on the effective integration of the Brayton gas turbine cycle with the Rankine bottoming cycle. Compactness and simplicity of the resulting overall system are of primary importance. Output from the bottoming cycle may be used to increase the shaft power of the core gas turbine, or to drive an electric generator to power auxiliary systems.

Phase I: Select a suitable intercooled gas turbine cycle. Develop bottoming cycle methods/concepts and predict thermodynamic performance of the overall system via computer modeling. Perform preliminary sizing studies and prepare preliminary drawings showing the integration of the gas turbine and the bottoming cycles. Select a preferred system and prepare detailed plan for Phase II effort.

Phase II: Construct a bread board demonstration unit using existing hardware to the maximum extent possible. Verify predicted system performance, size, weight, and volume.

Potential Commercial Market: An intercooled gas turbine engine with a compact, efficient bottoming cycle has unlimited commercial application potential for transportation (land, sea, air), power generation, and industrial processes. Large fuel cost savings will be the biggest benefit, brought about by greatly increased fuel efficiency.

TOPIC: A94-068 TITLE: Low Cost Rejuvenation of Thermal Fatigue in Metal Matrix Composite Material
Point of Contact: AVRDEC

CATEGORY: Exploratory Development

OBJECTIVE: Develop techniques and procedures to demonstrate the feasibility of damage recovery in metal matrix composite materials.

DESCRIPTION: Historically, material such as turbine disk and compressor disk have been fabricated from high temperature nickel base super alloy and directionally solidified alloys (DS). As these alloys are used in service, they accumulate thermal fatigue and creep fatigue type of damage. Many programs to date have been initiated to assess the magnitude of the damage that accumulates during service and to retire these disks for cause or otherwise using various safety criteria for this purpose. Many of these disks are warehoused at a great cost for later use where safety measures may not be as severe. A situation such as a national emergency would constitute a typical application. Concurrently, light weight high strength fiber reinforced composite materials have a possible application to replace these alloys in the turbine and compressor disk areas. It is the intention of this project to develop techniques and procedures that will allow the "safe reuse" of the fiber reinforced composite disks without the need for a high dollar rework or a high dollar storage cost.

Phase I: Develop and demonstrate the feasibility of concepts and techniques for use in the rejuvenation of metal matrix composite material that contain classical creep/fatigue and ratchet-strain types of damage.

Phase II: Develop and deliver prototype techniques and demonstrate the cost effectiveness and performance effectiveness of the use of these techniques on prototype specimens fabricated from a standard MMC material such as Ti-6-4/SCS-6 in use today.

Potential Commercial Market: Results will be applicable to future high tech uses such as propellers, impellers, turbine applications of all types such as disk, bearing supports, shafting, etc. Cost saving potential is enormous.

TOPIC: A94-069 TITLE: Low Cost, Hot Gas Throttling Valve, for Solid Fuel Based, Expendable, Tactical Missile Propulsion Systems

Point of Contact: MICOM

CATEGORY: Exploratory Development

OBJECTIVE: Development of a low cost, hot gas throttling valve, for solid fuel based expendable, tactical missile propulsion systems.

DESCRIPTION: Traditionally, tactical missile systems have exclusively utilized solid rocket propulsion. However, the mission requirements of the next generation of tactical missiles will demand a level of propulsion system flexibility that can not be met with a standard solid rocket. On-demand thrust control will be required, which will dictate the use of non-traditional solid propellant based propulsion systems such as: ducted rockets, hybrid rockets, and Air Turbo Ramjets (ATR). The solid fuel variants of these propulsion cycles employ a fuel rich gas generator as the fuel source. To obtain high performance (thrust), the gas generators of these systems must operate at relatively high maximum chamber pressures (up to 7000 psig) and temperatures (up to 2500 degrees F) levels. In addition, to provide thrust control (throttling), the mass flow rate of the gas generator must be modulated over a wide range (up to 10:1 turn down ratio). Finally, the flow rate modulation must be available on demand and under computer control.

To successfully develop high pressure, high performance, throttleable, solid fuel tactical propulsion systems, an on-demand throttling device is required. Thrust control of each respective engine can be effectively achieved through modulation of the gas generator fuel flow rate with a hot gas throttling valve. Consequently, technology is required for the development of low cost, light-weight, hot gas valves that can be utilized in the next generation of Army tactical throttleable solid propellant systems. The valves to be developed must incorporate the following features: compatibility with common gas generator solid propellant (e.g. AP/HTPB, GAP/C), flow rate insensitivity to downstream pressure fluctuations, maximum linearity over operating range, minimal hysteresis, 5:1 flow rate turn down ratio (10:1 desired), minimum 5000 psi chamber pressure (7000 psig desired), minimum 2500 degree F chamber temperature (3000 deg F), minimum 60 sec full throttle operation, rapid actuation (minimum to maximum flow rate in less than 100 msec), functionality with metalized fuels, low cost design consistent with tactical missile systems, minimized weigh t, minimized volume, electrical activation (analog or digital), continuum of on-demand available flow rates, self-contained sensors and feed-back control (if required), 10 year shelf-life, compatibility with tactical missile environment (storage transportation, and operating), compatible with microprocessor control, adaptability to a wide range of engine cycles and configurations. The system must take advantage of the expendable, short duration mission of tactical missiles to minimize cost and reduce weight and volume. Use of commercial (not aerospace) grade components are desired. The valve should employ generic technology and should be scaleable to accommodate a wide range of maximum flow rate (.1 to 50 lbm/sec).

Phase I: Under the Phase I effort, a heavy-weight, high pressure hot gas valve shall be designed, developed, fabricated, and demonstrated. This system shall be sized and designed for integration and operation with the MICOM Propulsion Directorate sub-scale direct-connect ducted rocket test facility. The sub-scale gas generator has a maximum chamber pressure of 3000 psig, a chamber temperature of 2000 deg F, a mass flow rate of 1 lbm/sec, a burn time of 30 sec, and a nominal O.D. of 5 in. Specific details of the MICOM sub-scale test hardware shall be provided after contract award. The device should incorporate as many of the desired features as possible. The contractor may demonstrate the system utilizing cold gas or inert hot gas. The demonstration must include some form of control system (preferably P.C. based) that can be employed to demonstrate on-demand flow rate control. At the completion of the effort the device must be delivered to the Government with any associated test hardware, control hardware and software (including source code) for independent experimental direct-connect evaluations utilizing a solid fuel gas generator and a ducted rocket combustor. Adequate spare and/or expendable valve components must be delivered to support a minimum of 5 hot gas tests.

Phase II: Under the Phase II effort a flight weight system shall be designed, developed, fabricated, and demonstrated that incorporates all the desired features. The maximum flow rate and final configuration shall be determined from an analysis of Army tactical missile system requirements. The final design shall be experimentally evaluated under the effort, over a wide range of conditions (transportation, storage, operational). Several devices shall be delivered to the Government for independent evaluation.

Potential Commercial Market: There are significant Military applications for this technology. This technology is an essential (enabling) element in the development of the next generation of high performance, mission-flexible/adaptable tactical missile systems. This technology will provide significant advances in tactical missile propulsion, consequently the market potentials is large. From a civilian perspective, commercial space launch vehicle could be developed that utilize this low cost tactical missile propulsion technology to significantly reduce acquisition and operating costs.

TOPIC: A94-070 TITLE: High Efficiency, Low Cost & Weight Heat Exchanger for Gas Turbine Engines
Point of Contact: TACOM

CATEGORY: Exploratory Development

OBJECTIVE: Develop materials and fabrication techniques for low cost, high temperature recuperator for advanced gas turbine engines.

DESCRIPTION: Recent advances in gas turbine engines resulted in high pressure ratios and high turbine inlet temperatures. To improve the fuel economy of these engines to the level comparable to the advanced diesel engines, recuperator technology has to be developed to withstand temperatures in the range of 1600-1800 F and higher if possible. Current recuperator technologies involve significant labor for fabrication resulting in high cost of recuperated gas turbine engines. Such high costs make the gas turbine unacceptable for application in the nonmilitary ground vehicles. The future technologies should address the cost issues. The weight and volume of the power plant are significant factors in its selection for application in ground vehicles. Hence, a smaller and lighter recuperator with good performance characteristics would enhance the acceptability of gas turbine engines for application interrestrial vehicles.

Phase I: Identify the materials and manufacturing processes to fabricate high performance, low costs and , low weight and volume recuperators.

Phase II: Procure materials and fabricate a laboratory prototype recuperator and demonstrate its performance.

Potential Commercial Market: Currently the automotive companies are evaluating the gas turbine engines for application in the hybrid vehicles. The future emission standards may force the use of low emission engines, like gas turbines, in the passenger vehicles. The potential for the application of gas turbine engines in the marine and commercial vehicles is also high.

A-6 POWER AND DIRECTED ENERGY

TOPIC: A94-071 TITLE: Extremely Lightweight Hydrogen Fuel Cells
Point of Contact: E&PSD

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate an extremely lightweight fuel cell stack.

DESCRIPTION: Future man-portable power supplies (approx. 300 watts and ≤5kG) will necessarily involve lightweight, high power density fuel cell stacks. Current fuel cell designs utilize polymer electrolyte membranes (PEM) in a bipolar arrangement where the cathode of one cell is electrically connected to the anode of its neighbor. Since fuels/oxidants delivered to anodes/cathodes must be physically separated in order to prevent mixing, there is considerable weight, cost, and engineering complexity in present fuel cell systems. In addition, the entire assembly must be firmly bolted together thus adding considerable weight for end plates and bolts. It would be desirable to design a fuel cell system where much of the system weight is eliminated. One possible arrangement could involve minimizing the weight of the materials used in constructing bipolar fuel cell stacks. Another approach could involve elimination of the bipolar configuration entirely by using a single polymer electrolyte membrane (PEM) sheet as the proton conducting electrolyte for a number of individual fuel cells. Fuel and oxidant would be delivered to opposite sides of the sheet which would be shared and utilized by all cells within the fuel cell stack. Individual fuel cells would be created by forming electrically conducting zones alternating with electrically insulating zones contained within the PEM electrolyte itself. Since the large PEM sheet is used to isolate and define individual cells, thermal and water management problems are minimized.

Phase I: Should result in a lightweight, small size, prototype fuel cell stack and/or a conceptual design for a complete fuel cell system where either extremely lightweight construction materials are used or, alternatively, a nonbipolar arrangement is used. The operating fuel cell must consist of at least three individual cells. The scaled up version of the design should result in approx. 300 watt fuel cell system weighing ≤5kG.

Phase II: Will result in construction of approx. 300 watt fuel cell stack with the minimum possible weight.

Potential Commercial Market: Lightweight fuel cells should have direct applications in portable power applications such as electric vehicles and various electronic devices.

TOPIC: A94-072 TITLE: High Frequency Alternator, Power Frequency Conversion (HFA-PFC) Technology for Lightweight Tactical Power Generation

Point of Contact: CECOM

CATEGORY: Advanced Development

OBJECTIVE: To explore the potential for generator set size and weight reduction through the use of integrated power components. Components include a lightweight, High Frequency Alternator (HFA) coupled with Power Frequency Conversion (PFC) components to produce MIL-STD power (such as 60 Hz, 120 VAC). A control system would maintain the proper output frequency and voltage for transient and steady state load conditions and changing engine speed.

DESCRIPTION: There exists excellent potential for reducing the size and weight of DOD tactical generator sets using the HFA-PFC concept. In addition to potential weight reductions, this concept de-couples the output frequency from engine speed so that the engine can run at a speed dictated by the operational environment (higher speeds for maximum power or lower speeds for maximum fuel efficiency and reliability). Such performance flexibility and size/weight reductions would improve the operational performance of the gen- sets due to improved deployability and mobility, and reduced handling requirements. Such performance goals match Army requirements and scenarios for highly dynamic "shoot and scoot" situations expected in future conflicts. A weight driver for current DoD gen-sets is the 60 Hz alternator which is generally driven at 1,800 rpm by the engine. Alternator size and weight decrease dramatically when speed and frequency are increased. Engine power density can also be increased because the engine can be run at its optimum power speed for high power loads. The PFC components condition alternator power to produce MIL-STD frequency and voltage (such as 60 Hz and 120 VAC) independent of engine speed. Commercial 1,800 rpm, 60 Hz alternators represent static technology with little performance improvements foreseeable. Power semiconductors (the major component of the PFC) are a rapidly advancing technology with excellent potential for further size/weight reductions in the future.

Phase I: The contractor shall determine optimum HFA-PFC design options for the following power ranges: 5-30 kW, 30-100 kW and 100-1,000 kW. Determine the optimum HFA design and the optimum power semiconductor technology and topology for the given power ranges.

Phase II: The Government can determine the optimum power range(s) to be explored during Phase II based on Phase I results analysis and review.) The contractor shall fabricate and test prototype full scale or sub-scale (as appropriate) versions of the HFA-PFC. The mobility and deployability benefits due to weight reductions shall be quantified along with studies to determine producibility and logistics issues associated with HFA-PFC based gen-sets.

Potential Commercial Market: HFA-PFC technology would be applicable to the commercial gen-set market segments where size/weight and/or fuel efficiency are key concerns. The major life cycle cost element of commercial gen- sets is fuel cost, so being able to produce 60 Hz at the most efficient engine speed could be a distinct advantage.

A-7 BIOTECHNOLOGY

TOPIC: A94-073 TITLE: Recombinant Antibodies for Chemical/Biological Warfare (CBW) Detection
Point of Contact: ERDEC

CATEGORY: Exploratory Development

OBJECTIVE: To design recombinant antibodies for detecting CBW agents and to develop expression systems for their scale-up production.

DESCRIPTION: The Army has a requirement to develop antibodies for sensors and test kits for detection of pathogens, toxins and chemicals. The current approach is based on well known hybridoma technology and, while successful, has several drawbacks. Time required to develop a particular antibody is long, impeding the Army's ability to quickly respond to new threats; production is relatively expensive; hybridoma cell lines are often unstable; it is not possible to design antibodies with particular binding characteristics.

Phase I: The objective is to demonstrate the ability to develop a phage display selection system, construct an immunoglobulin gene library and select specific antigen binding clones. A plan for selection, mutation and expression of high affinity clones in a bacterial system will be described for successful transition to Phase II.

Phase II: Two objectives will be pursued for Phase II. Parameters for scale-up of the bacterial expression system to at least 30 L will be defined and demonstrated, and antibody yields will be optimized. Second, specific antigen binding peptide fragments will be developed from existing cDNA libraries without using immunized animals.

Potential Commercial Market: The products and processes developed from this project will have widespread applications in environmental monitoring (e.g., pesticides in soil and ground water), industrial processes (e.g., test kits) and agriculture (e.g., antibiotics in milk). Pharmaceutical firms usually contract out for their antibody needs and this technology will confer many advantages in speed and cost to the developer.

TOPIC: A94-074 TITLE: Self-Organizing Biomolecular Materials as Structural and Patterning Elements for Device Fabrication
Point of Contact: ARO

CATEGORY: Basic Research

OBJECTIVE: Characterize process and product for self-assembling, pattern-forming biological macromolecular array.

DESCRIPTION: A number of complex biological macromolecules offer appealing potential for their ability to self-assemble at the nanometer level in two-dimensional crystal lattice layers on surfaces, or as reproducible uniform three dimensional structures in solution or on surfaces. This new class of biomolecular materials comprises various combinations of proteins and lipids, for the most part, and in some cases includes complex carbohydrate molecules. Because the distribution and orientation of their associated functional groups are in both cases precisely defined, they serve as structural and patterning elements for fabrication of new generation optical and electronic devices, for separation technology, or for other advanced-concept materials. Basic research is needed to better understand self-organizing processes in nature and to learn how we might be able to more fully utilize the underlying principles, exploit the process, and incorporate the product, as biological or biomimetic components, for synthetic application.

Phase I: Identify and characterize self-organizing biomolecular system and provide description of synthetic and processing pathways involved in elaboration of final functional product by cell.

Phase II: Describe the manner in which biological material structure at the molecular level is a determinant of macroscopic pattern formation. Provide means for manipulation of system via molecular genetic, biochemical and/or biophysical modification, permitting purpose-built design changes with potential for use as device elements.

Potential Commercial Market: The potential for fault-free manufacture of important electronic, photonic or other arrayed device components, highly ordered at extremely small dimensions, using biological or biologically-derived templating methods, is very high. With improved understanding of how complex nanometer scale biological structures are fabricated via self-assembly in nature, there should be substantial commercial interest in further development and application of the technology.

TOPIC: A94-075 TITLE: Development of Biosensor and Assays for the Detection of BW Agents Using Fluoresceinated and Biotinylated Antibody and Nucleic Acid Probes
Point of Contact: MEDICAL

CATEGORY: Basic Research

OBJECTIVE: Develop or modify a preexisting biosensor device to enable detection of BW agent specific antigens or extracellular products and toxins using biotinylated and fluoresceinated "capture" and "detection" antibodies, at picogram or sub-picogram levels, from biological fluids.

DESCRIPTION: The developed or modified biosensor must also be capable of detecting amplified BW agent specific nucleic acids which are liquid hybridized with fluoresceinated and biotinylated probes from biologic fluids. The system must be simple, sensitive and rapid for field use. The system must be applicable to biologic fluids such as blood, urine, saliva and diarrheal stools. Biologic agents and toxins to be detected by the antigen capture and PCR methodologies include anthrax, plague, tularemia, cholera, VEE ricin, Staph enterotoxins, botulinum toxins and saxitoxin. Monoclonal and polyclonal antibody reagents and specific PCR primer sets and probes will be provided for use in the development biosensor assays.

Phase I: Design a system for field use capable of detecting picogram and sub-picogram levels of a single BW agent specific antigen or toxin by antigen capture and by detection of liquid probe hybridized PCR amplified nucleic acids.

Phase II: Develop assays for other BW agents and toxins and evaluate system against other established diagnostic methods using clinically relevant specimens.

Potential Commercial Market: Several BW agents and toxins that pose a military threat are also significant public health hazards in the US and throughout the world. This system and developed assays would be of great value in determining causes of undetermined infectious diseases and food poisoning and could be used in hospital laboratories or physicians' offices.

A-8 LIFE, MEDICAL AND BEHAVIORAL SCIENCES

TOPIC: A94-076 TITLE: Adaptive Display of Critical Battlefield Information for the Individual Commander
Point of Contact: HRED

CATEGORY: Exploratory Development

OBJECTIVE: Using natural language processors and rule based systems, develop an automatic alert and display structure for the commander based on his individualized model of the battlefield tactical environment.

DESCRIPTION: Fast moving battles similar to the situation in southwest Asia result in the commander outpacing his battle information. Modern information systems such as Tactical Information Broadcast System (TIBS), Common Ground Station (CGS), Intra-vehicle Information System (IVIS), and All Source Analysis System (ASAS) ensure the commander a plethora of battlefield information during the actual battle. If all the information was forwarded to him, not only would the commander be overwhelmed, but his staff would be inundated as well. Smart filters are needed to automatically extract the critical information for the commander and ensure its timely display. The problem is multifaceted; it requires a thorough understanding of the cognitive requirements of the commander as well as intelligent software that can interpret the commander's requirements. Research at ARL (Warner, 1993) indicates that the type and format of information the commander requires is highly dependent on his tactical decision task. This suggests that two related problems need to be solved in conjunction with an adaptive information filtering system. The first involves research in how to capture the commander's mental model as critical information is being received during the heat-of-battle. The second problem is how to produce artificially intelligent software that extracts battle critical information for the commander. Simply extracting information from multiple information sources could easily result in a mismatch between the commander's ongoing decision processes and the display of the current battle situation. In fact, the commander's information requirements are likely to be highly individualized and to change as a function of where he is in the battle. The filters must act as a "pull" system and be intelligent enough to adapt to individual commanders as well as adapt to the changing information environment.

Phase I: The initial effort will demonstrate adaptive logic for filtering battlefield information. The adaptive logic must be based on individual commanders inputs and be able to change as function of battlefield conditions. The first phase shall demonstrate that a subject matter expert's (SME) information requirements, preferred formats, and changing tactical priorities could be represented in software to serve as the criteria for an adaptive filter and display system. The criteria would set filter parameters which automatically parse incoming intelligence and battlefield information for high value information. The culmination of Phase I is a demonstration of an adaptive information system that filter incoming data and display the type and format of information based on the individual commander's preference structure.

Phase II: The second phase will demonstrate individualized software modules that can be easily programmed by military operators. Using simulation experiments, advanced natural language processors, and cognitive engineering technology, a practical interface environment for the commander will be designed. The interface shall define the commander's requirements for battle management and shall be easily implemented as part of the planning process. The interface an d underlying software shall be rapidly prototyped and rigorously tested in field and realistic simulation exercises to evaluate the concepts in near operational environments.

Potential Commercial Market: The potential market would be high volume banks, stockbrokers, and large scale inventory control systems--any industry that is inundated during peak business hours. "Smart" filters which identify messages that must be responded to immediately has a high commercial value of decreased cost and increased effectiveness. Information processing systems based upon intelligent filters will be the next revolution in information technology.

TOPIC: A94-077 TITLE: Representing and Analyzing Mental Models
Point of Contact: ARI

CATEGORY: Exploratory Development

OBJECTIVE: To develop and validate a rapid means of representing an individual's mental model of a battlefield situation and of inferring the knowledge structures that underlie it.

DESCRIPTION: The development of concept maps to represent an individual's understanding of the entities and relationships involved in a complex situation is a lengthy, highly interactive process. As such, it is not particularly useful in naturalistic decision-making research where the mental models are very dynamic and interaction with the researcher alter the decision-making process. Yet prior research on decision-making and problem solving expertise has shown that problem representation is a key aspect of this expertise. Also, if there w as a rapid means of externally representing mental models, it who greatly enhance the building of shared understandings. A related research problem is inferring the knowledge structures that underlie the mental model. Our interpretations of the external world are based on the interaction of goals with our knowledge of the objects and relationships involved in the problem situation and task. What a subject typically conveys in a problem solving protocol is the interpretation (i.e, mental model). The reasoning involving the underlying knowledge structures may never reach conscious awareness, especially if the subject is an expert. We need a reliable means of inferring those knowledge structures from resulting mental models.

Phase I: Phase I will involve the identification and evaluation of means of rapidly representing mental models. The expected result is the selection of two methods to be tested in Phase II.

Phase II: Phase II will begin with final selection, development and validation of a method. Subsequent work will involve research into inferring underlying knowledge structures from mental models and applying the method to groups in the development of shared mental models.

Potential Commercial Market: A user-friendly means of externalizing the reasoning behind management decisions and conveying it to others will have wide application in a variety of organizations.

TOPIC: A94-078 TITLE: Develop Lightweight, Portable, Non-invasive Physiologic Sensors for Multi-site Determination/Quantitation of Surface and Deep Tissue Oxygenation
Point of Contact: MEDICAL

CATEGORY: Exploratory Development

OBJECTIVE: To non-invasively measure (at multiple sites) the oxygenation of deep tissues (e.g., large muscle masses). The sensor must be capable of interface with standard computer input ports, in order to record, store and eventually transmit the oxygenation status data.

DESCRIPTION: There is a growing need for sophisticated biochemical and physical sensors to monitor the physiologic status of casualties on the battlefield. Monitoring of this type will augment current abilities to diagnose and triage trauma victims, and to evaluate tissue oxygenation and/or areas of tissue hypoxia during evacuation (transport), as well as during stabilization, resuscitation and treatment. Such sensors should collect desired information rapidly and reliably, and interface with both real-time display devices and data storage devices of standard computers. Currently-described sensors must be capable of sampling multiple sites simultaneously, and acquire data on deep-tissue (e.g., skeletal muscle) oxygenation.

Phase I: Produce prototype components for such a system from existing or novel materials, capable of demonstrating the proof-of-principle.

Phase II: Integration of all components into a pre-production prototype. Demonstrate the features and capability of the prototype in tissues simulating battlefield hemorrhage and shock.

Potential Commercial Market: The use of such physiologic sensors is anticipated not only under battlefield conditions, but also in a variety of emergency medicine scenarios, including: emergency response teams (both urban and rural), hospital emergency rooms, surgery, intensive care and coronary care suites, etc.

TOPIC: A94-079 TITLE: Lightweight, Portable, Non-invasive Physiologic Sensors for Multi-site Determination/Quantitation of Surface & Deep Tissue Microvascular Blood Flow

Point of Contact: MEDICAL

CATEGORY: Exploratory Development

OBJECTIVE: To non-invasively measure (at multiple sites) the microvascular blood flow of deep tissues (e.g., large muscle masses). The measurement must be similar in signal or design to current laser doppler technology. The sensor must be capable of interface with standard computer input ports, to record, store and eventually transmit the oxygenation status data.

DESCRIPTION: There is a growing need for sophisticated biochemical and physical sensors to monitor the physiologic status of casualties on the battlefield. Monitoring of this type will augment current abilities to diagnose and triage trauma victims, and to evaluate tissue oxygenation during evacuation (transport) and/or stabilization, resuscitation and treatment. Such sensors should collect desired information rapidly and reliably, and interface with both real-time display devices and data storage devices. Currently-described sensors must be capable of sampling multiple sites simultaneously, and acquire data on deep-tissue (e.g., muscle) oxygenation.

Phase I: Produce prototype components for such a system from existing or novel materials, capable of demonstrating the proof-of-principle.

Phase II: Integration of all components into a pre-production prototype. Demonstrate the features and capability of the prototype in tissues simulating battlefield hemorrhage and shock.

Potential Commercial Market: The use of such physiologic sensors is anticipated not only under battlefield conditions, but also in a variety of emergency medicine scenarios, including: emergency response teams, hospital emergency rooms, surgery, intensive care and coronary care suites, etc.

TOPIC: A94-080 TITLE: Develop Lightweight, Portable, Non-invasive Physiologic Sensors for Multi-Determination and/or Quantitation of Surface and Deep Tissue pH

Point of Contact: MEDICAL

CATEGORY: Exploratory Development

OBJECTIVE: To non-invasively measure (at multiple sites) the acid-base status (pH) of deep tissues (e.g., large muscle masses). The sensor must be capable of interface with standard computer input ports, in order to record, store and eventually transmit the oxygenation status data.

DESCRIPTION: There is a growing need for sophisticated biochemical and physical sensors to monitor the physiologic status of casualties on the battlefield. Monitoring of this type will augment current abilities to diagnose and triage trauma victims, and to evaluate tissue pH following trauma and/or shock during evacuation (transport), as well as during stabilization, resuscitation and treatment. Such sensors should collect desired information rapidly and reliably, and interface with both real-time display devices and data storage devices of standard computers. Currently-described sensors must be capable of sampling multiple sites simultaneously, and acquire data on deep-tissue (e.g., muscle) pH.

Phase I: Produce prototype components for such a system from existing or novel materials, capable of demonstrating the proof-of-principle.

Phase II: Integration of all components into a pre-production prototype. Demonstrate the features and capability of the prototype in tissues simulating battlefield hemorrhage and shock.

Potential Commercial Market: The use of physiologic sensors is anticipated not only under battlefield conditions, but also in a variety of emergency medicine scenarios, including: emergency response teams (both urban and rural), hospital emergency rooms, surgery, intensive care and coronary care suites, etc.

TOPIC: A94-081 TITLE: Establishment of Methods for Determining Gene Function in the Malaria Parasite
Point of Contact: MEDICAL

CATEGORY: Exploratory Development

OBJECTIVE: Develop methods for establishing the functionality of genes in Plasmodium sporozoites.

DESCRIPTION: The recent success of DNA transfection in several protozoan parasites suggests that these methods will also be applicable for screening the functionality of genes in the malaria parasite with the aim of defining candidate molecules for vaccine development or the development of attenuated which could themselves be used as a vaccine.

Phase I: Development of transfection protocols to allow both the transient and stable expression of genes introduced into Plasmodium sp., with emphasis on Plasmodium sp. sporozoites.

Phase II: Assess the status of transfected DNA in Plasmodium with regard to recombination, chromosomal integration, and targeted gene replacement. Develop methods to screen genes for function and to determine whether targeted genes are essential for parasite viability or infectivity, with emphasis on the sporozoite or liver stages.

Phase III: Screen genes for function.

Potential Commercial Market: Immunization with radiation-attenuated sporozoites protects human subjects from malaria, and natural exposure to malaria induces immune responses that dramatically reduce the morbidity and mortality associated with malaria. However, the parasite proteins which elicit these responses are not known. A company that develops methods for identifying gene function in Plasmodium will be in the unique position to target promising gene products for vaccine development.

TOPIC: A94-082 TITLE: Gene Transfer Vectors for Malarial Genes
Point of Contact: MEDICAL

CATEGORY: Exploratory Development

OBJECTIVE: To develop nucleic acid vectors to carry malarial genes across red blood cell membranes, parasitophoresis vacuolar membranes and parasite membranes that allow insertion of DNA into the parasite genome.

DESCRIPTION: It is presently impossible to transfer genes into the Plasmodium falciparum malarial genome. The stages of the parasites development that exist outside the host cell are not amiable to experimental manipulation. Those stages that exist inside host cells have an elaborate array of membranes between the parasite's nucleus and the outside of the cell. In order to do modern genetic analysis of parasite genes the technique of gene transfer must be developed. Standard methods of gene transfer have not been successful. It is hoped that natural DNA or RNA vectors that have the ability to cross membranes can be used to deliver genes into the parasite's nucleus. Vectors must be able to be used in BL1 or BL2 conditions set out by the Recombinant DNA Advisory Committee (RAC).

Phase I: Experimental development of vectors containing malarial promoter sequences and detector genes such as luciferase, beta-galactosidase or neomycin. Testing of these constructs to delivery genes to developing parasites in red blood cells.

Phase II: Construction, in conjunction with the Walter Reed Army Institute of Research, of vectors containing malarial genes and genetic analysis of specific genes in the parasite by either replacement or interruption of gene sequence.

TOPIC: A94-083 TITLE: Cellular Immune Response to Diseases of Military Importance
Point of Contact: MEDICAL

CATEGORY: Basic Research

OBJECTIVE: To develop new, sensitive, quantitative tests to monitor cellular immunity as a response to vaccinations.

DESCRIPTION: Recovery from, protection against and perhaps the disease process itself, of several diseases of military importance are mediated by cellular response or immunity. Sensitive, quantitative, and easily applied tests to detect relevant responses are needed both in evaluation of the immune status of antibody-negative subjects and to monitor the disease process and vaccine development. Typical systems in which such responses are thought to be biological relevant include diseases caused by Q-fever, filoviruses, VEE, ricin and the staphylococcal enterotoxins.

Phase I: Develop an assay to aid in evaluation of the immune status of antibody-negative subjects and to monitor the disease process and vaccine development for one agent of interest.

Phase II: Show the utility of immuno assay(s) for other classes of agents of interest.

Potential Commercial Market: Monitoring cellular immunity may be used to evaluate immune status of antibody-negative individuals vaccinated against a variety of infectious diseases. Development of a sensitive quantitative test of cellular immunity would be of potential interest to all vaccine manufacturers in order to quantify levels of protection demonstrated by a new or existing vaccines.

TOPIC: A94-084 TITLE: Delivery of Vaccines by Biodegradable Polymeric Microcapsules with Bioadherence Properties
Point of Contact: MEDICAL

CATEGORY: Basic Research

OBJECTIVE: To demonstrate the feasibility of biogradable microspheres for the encapsulation of vaccines with or without immunoadjurants which would evoke complete protection for a duration of at least one year by single administration.

DESCRIPTION: To achieve maximum protection, most vaccines require two or three booster doses, causing logistical difficulties. Furthermore, parenteral administration of the vaccine by trained medical personnel considerably increases the cost of vaccination. Therefore, biodegradable microspheres for the encapsulation of vaccines with or without immunoadjuvants are needed which would evoke complete protection for a duration of at least one year by single administration. Toxins of principal interest include ricin, microcystin, botulinum toxin, saxitoxin and staphylococcal enterotoxins, clostridial perfringens toxins as well as other low molecular weight, peptide, and protein toxins. Infectious agents of interest include anthrax, plague, tularemia and selected virus diseases (e.g. VEE).

Phase I: Demonstrate feasibility in laboratory animals, using a vaccine against agents listed above.

Phase II: Extend to include preclinical trails to support in submission.

A-9 ENVIRONMENTAL AND GEOSCIENCES

TOPIC: A94-085 TITLE: Development of Non-Toxic Cores for Small Caliber Projectiles
Point of Contact: ARDEC

CATEGORY: Exploratory Development

OBJECTIVE: To utilize state of the art polymer technology to develop high density, metal injection molded polymer compounds having the required characteristics for an effective and functional projectile/core. The result will demonstrate the application of cost effective, lead-free environmentally safe alternate materials for small arms ammunition.

DESCRIPTION: The successful development of two small caliber ammunition rounds, the type classified Caliber .50 saboted light armor penetrator (SLAP) and the 7.62mm short range training ammunition (SRTA), was due to recently developed engineered polymer resins. The SLAP utilizes a polyetherimide, PEI resin while the 7.62mm SRTA consists of a high density, 85% bronze filled nylon-11 material. Both are high temperature, high performance type engineered resins. Further development in the area of high performance polymer compounds could result in the identification of a material suitable for application in small arms ammunition projectiles. The development of this material would result not only in lower projectile costs due to the fact that the time consuming and costly practice of removing lead from practice ranges and lead dust from processing areas will no longer be required. In addition, various starches and other proven biodegradable additives can be incorporated in the polymer resin resulting in a non-toxic material that will decompose completely in water or soil leaving no synthetic or toxic residues. The metal injection molded projectile development program will utilize high density, metal injection molded compounds of fine metal powders in a polymeric binder. Metal materials would include bronze, stainless steel, copper, and/or aluminum. Specific gravities of 6.0 grams/cc have already been achieved with copper filled polymer compounds and it is estimated that specific gravities of 10-12 grams/cc (steel is approximately 8 grams/cc while lead is approximately 11.5 grams/cc) can also be achieved with additional research. Alloys of these materials will also be used in order to control the cost and physical properties of the material such as specific gravity, compressive/tensile strength and elongation. These materials will be engineered to provide the characteristics required of small arms ammunition with the 7.62mm M80 cartridge serving as the test bed for this development.

Phase I: During the initial development effort the properties of existing polymer compounds will be analyzed to determine the effects of various alloying materials on the physical properties of the compound. In addition, a literature search will be conducted to determine the toxicity of the candidate materials. A matrix of required and desired material properties for the polymer projectile core will then be generated. This information will form the basis for the development of several candidate polymer compounds. The contractor will then mold polymer projectile cores using the developmental compounds. The cores can either be molded directly in the existing metal projectile jackets or molded separately and later inserted into the jacket.

Phase II: The prototype projectiles will be delivered to ARDEC for ballistic test and evaluation to determine their safe and effective use in 7.62mm M240/M60 series machine guns as well as any effects on projectile flight characteristics due to the core material. It is anticipated that several iterations of development, fabrication, test and evaluation will occur during this effort. If this material/projectile is successful in 7.62mm applications, expanded applications can be investigated: e.g. 5.56mm, 9mm and .50 caliber ammunition.

Potential Commercial Market: The technology developed under this program can be utilized by all commercial manufacturers of small arms ammunition. Currently, there is a great deal of concern in the private sector over the contamination of shooting range s due to high lead content. For the armed services, the development of a non-toxic alternate material projectiles would allow continued training on ranges that are currently in danger of being closed due to the high levels of lead contaminants in the surrounding areas. In order for both the military and public ranges to remain open, costly clean-up procedures that provide only a temporary solution are required. Use of the alternate material projectiles will allow the soldiers to continue training on existing ranges, thereby enhancing their combat effectiveness, without the associated range clean-up expenses.

OSCRS: This technology will provide cost reductions over the entire life cycle of the ammunition. Full scale production costs will be substantially reduced and costs associated with the decontamination and clean up of firing ranges will be virtually eliminated. Other benefits include improved product uniformity and improved ammunition accuracy as well as the identification of an alternate lead free material for small arms projectile s.

TOPIC: A94-086 TITLE: Environmental Interaction for EOSAEL
Point of Contact: BED

CATEGORY: Exploratory Development

OBJECTIVE: Interface individual EOSAEL modules with WINDOWS on CD ROM for use on 486 and equivalent PCs.

DESCRIPTION: The Environmentally Oriented Systems Atmospheric Effects Library (EOSAEL) is a state-of-the-art computer library comprised of fast-running, theoretical, semi-empirical, and empirical computer programs (called modules) that mathematically describe various aspects of electromagnetic propagation in the ultraviolet, visible, near-, mid-, far-infrared, and millimeter wave for battlefield environments. The modules address transmission through both the natural environment and through man-made obscurants which are common on the modern battlefield. The modules are engineering oriented with the philosophy to give reasonably accurate results with the minimum in computer time for conditions that may be expected on the realistic battlefield. EOSAEL contains twenty-five modules dealing with various aspects of atmospheric propagation that deal with degradation of target signatures. Placing EOSAEL on CD ROM running under WINDOWS would allow for the easy examination of atmospheric effects by soldiers and civilians alike.

Phase I: Develop a plan to interface all EOSAEL modules with WINDOWS and provide a prototype for the EOSAEL COMBIC (Combined Obscuration Model for Battlefield Induced Contaminants) module. Plans for front ends for each of the twenty-five modules must be developed along with icons for each of the individual modules. In addition to placing the prototype COMBIC module on CD ROM implemented under WINDOWS, this plan will show how all of the EOSAEL modules will reside on CD ROM running under WINDOWS for easy use on 486 and equivalent PCs.

Phase II: Development of a software package based on the development plan in Phase I. This software package shall reside on CD ROM and will run all EOSAEL executables on 486 PCs and equivalents under WINDOWS. The potential EOSAEL WAVES (Weather and Atmospheric Visualization Effects for Simulation) suite of four codes shall also be included. Context sensitive help using the WINDOWS help facility shall be employed for all modules. Documentation shall be provided in WordPerfect format in a collective document explaining how to run the modules under WINDOWS.

Potential Commercial Market: A large potential commercial market exists in the application of these modules to civilian projects: laser communication, determination of vehicular-raised dust pollution, light (broadband and laser) attenuation through natural and man-made pollutants (fog, rain, snow, oil fires, etc.), dispersal of fire and smoke plumes, illumination levels under various cloud types, determination of scattered radiation levels, radar propagation, etc.

TOPIC: A94-087 TITLE: Destruction of Military Relevant Chemicals and Wastes
Point of Contact: ARO

CATEGORY: Exploratory Development

OBJECTIVE: Detoxification of hazardous chemicals and chemical agents through the use of non-polluting destructive adsorbents.

DESCRIPTION: Because of the millions of pounds of military chemical wastes generated annually, there is a need for innovative technologies to destroy these chemical wastes. Destructive Absorption Technology (DAT) is a non-polluting treatment process that has been demonstrated to be theoretically capable of treating hazardous substances, including chemical warfare agents, chlorocarbons, and contaminated soil and debris while allowing for reclamation of valuable byproducts as fuels or feedstocks. DAT performance is dependent upon the synthesis and use of ultrafine (nanoscale), highly reactive metal oxides such as CaO and MgO as destructive adsorbents. Excellent results have been obtained in the laboratory with specially prepared (by aerogel/hypercritical drying) metal oxides. However, for DAT to be commercially used, easier and less expensive methods for synthesis of the destructive adsorbents are necessary.

Phase I: New approaches to synthesis need to be addressed in Phase I. Surface areas need to be monitored and correlated with the destructive capacity using various stimulants and chlorinated solvents as substrates.

Phase II: A reactor design for large scale operation needs to be decided upon and a prototype will be built. Designing and testing of this prototype will be the main thrust of Phase II. Consideration should also be given to development of a portable or moveable system, which would be more useful at sites of relatively small amounts of contamination.

Potential Commercial Market: DAT has potential for use as a non-polluting, closed loop reclamation alternative to incineration for detoxifying hazardous wastes. It will be used by waste reclamation companies which typically offer solidification and incineration treatment services and sell landfill space for disposal of wastes and treatment residues. Other applications as air scrubbers are also likely.

TOPIC: A94-088 TITLE: Destruction of Chemical Warfare Agents by Efficient Semiconductor Photocatalysis Under Solar Irradiation
Point of Contact: ARO

CATEGORY: Basic Research

OBJECTIVE: Develop photocatalytic system for efficient use under solar irradiation.

DESCRIPTION: The Army has a need for new and innovative technologies for destroying chemical stockpiles and chemical waste. A potential technology is semiconductor-catalyzed photooxidation. TiO2 photocatalysis has received considerable attention using both artificial and solar irradiation, however, because only about 1% of the solar spectrum is utilized by TiO2, photocatalysis is typically quite inefficient outdoors. Several approaches have been undertaken to extend the absorption of TiO2 into the visible region including doping TiO2 and sensitizing TiO2 by charge injection using dyes. Although improvements have been reported, a breakthrough leading to an efficient solar photocatalytic unit has not yet been realized. This announcement is looking for new and innovative approaches (which may/may not be related to those noted above) to developing an efficient solar photocatalytic system. Proposals are not limited to studies of TiO2.

Phase I: Carry out basic research which demonstrates the potential for significantly improved photocatalytic activity under solar irradiation.

Phase II: Construct a photocatalytic reactor and demonstrate efficient solar photocatalytic degradation of compounds of interest to the Army.

Potential Commercial Market: A successful solar photocatalytic system would received wide spread use as a low cost, low technology method for waste remediation. Some of the compounds that could be treated include PCBs, TCE, phenols, chlorine and nitrogen t containing aromatics, and pesticides. This technology would be of great interest to businesses which use solvents that require disposal, and chemical and pesticide manufacturers.

TOPIC: A94-089 TITLE: Autonomous, Coherent Eye-Safe Lidar Wind Field Sensors
Point of Contact: ARO

CATEGORY: Basic Research

OBJECTIVE: To develop an autonomous, coherent eye-safe laser radar to detect hazardous wind conditions in the approach and departure ones for Army, DoD, and civilian aircraft. This device would operate in the clear air (non-precipitating) conditions to enhance the all-weather detection of the conditions. The device must be capable of stand-alone minimal maintenance similar to millimeter or centimeter radar devices.

DESCRIPTION: Sensor systems using millimeter and centimeter wavelength radars have the ability to sense those wind field conditions which pose hazards to air traffic during landing or takeoff operations provided that the ambient atmosphere has sufficient moist, turbulent eddies. Under dry air conditions, millimeter wave (MMW) and microwave radars do not have sufficient sensitivity to detect dangerous aeronautical conditions. It is precisely under these clear air conditions that optically eye-safe lidars have the potential to detect and quantify aeronautically dangerous conditions. For an all weather capability, a combined lidar/radar system may well be required. What is needed is t he technology to make a coherent lidar system autonomous, capable of continuous calibrated operation at full sensitivity. In addition to the development of the necessary coherent lidar technology, algorithms for the fusion of the MMW and lidar data will have to be developed.

Phase I: Develop the design concepts necessary to produce an autonomous lidar system operating at eye-safe frequencies that is capable of detection of wind speed by the doppler shift. Design criteria should include principles that will eliminate the need for quasi-continuous human monitoring and intervention into the lidar operation, the data acquisition, and the data analyses.

Phase II: Develop a prototype wind sensing lidar and test the concepts identified in Phase I that will permit autonomous operation.

Potential Commercial Market: Should a reliable, semi-autonomous, all weather microburst detector be developed, every major airport in the world would be a potential buyer. A very large market exists for a proven system with adequate support.

TOPIC: A94-090 TITLE: Real Time Monitor for Dangerous Air Emissions from Cleanup Sites
Point of Contact: CERL

CATEGORY: Exploratory Development

OBJECTIVE: To develop real time monitoring for dangerous air emissions at hazardous waste cleanup sites.

DESCRIPTION: At hazardous waste cleanup sites, worker protection is a critical issue. Air sampling for worker protection is dictated by NIOSH, while air sampling for community protection is dictated by the EPA. Typically workers take precautionary measures and don cumbersome clothing which renders their cleanup efforts inefficient and which seem to go well beyond the reasonable requirements of the job. It is the practice of both industry and government to overprotect workers. Laboratory analyses usually take too long to be of any use in making decisions for the upgrade or downgrade of worker protection. There is a need to determine in real time, the quantity and types of air emissions from sites that are being remediated so that worker protection can be adjusted accordingly. Parameters such as remediation techniques, the environmental conditions at the remediation site and worker exposure must all be investigated.

Phase I: Select typical air emissions released during remediation, which require monitoring. Evaluate real time monitoring possibilities for these air emissions and select the appropriate monitoring techniques for testing. Determine the relationship of emissions measured to environmental conditions such as weather, soil concentration, activity at the site, etc.

Phase II: Field test the real time monitoring methods at several sites to determine their usefulness.

Potential Commercial Market: There is currently no real time monitoring of air pollution emissions for worker protection. This information would be invaluable to the remediation industry for worker safety and protection.

TOPIC: A94-091 TITLE: In-Situ Electronic Sensors to Determine Analytes in Cold-Regions Soils
Point of Contact: CRREL

CATEGORY: Basic Research

OBJECTIVE: To develop electronic sensor systems which can quantify C02 02, NH4+, NH3, and N03- concentrations in soil atmospheres and soil solutions at temperatures as low as -10 C.

DESCRIPTION: Many current and former DoD installations in cold regions have contaminated soil sites. Bioremediation and natural attenuation are promising cost-effective approaches to treating these sites, but their use is inhibited by our limited ability to make in-situ measurements of the effect of remediation treatments, naturally occurring processes, or both. For research and operational purposes, a clearer and more defined three-dimensional picture of changes in solution and vapor concentrations of contaminants, microbial substrates and their intermediates, and the sub-soil environment must be made and the data accessible from remote systems.

Phase I: 1.) Identify appropriate existing chemical or physical sensing mechanisms and need for new sensors. 2.) Develop prototype system using existing sensors and data-logging systems. 3.) Test prototype. 4.) Evaluate the feasibility of using state-o f-the-art sensor technology to address new capability needs.

Phase II: 1.) Develop prototype for new sensors to address sensor needs. 2.) Laboratory test and evaluation of new sensors under extreme low temperature environmental conditions. 3.) Field application of sensor system at DoD related site.

Potential Commercial Market: Contaminated sites at DoD and civilian sites are in the process of being identified. The number of sites is consistently growing due to increased effort and improved ability to locate sites. A recent trend is towards gaining a better understanding of the effects of imposed treatments compared to the potential for self-treatment with minimal input. Both of these strategies require a better understanding of the in-situ, three-dimensional processes occurring in the soil.

TOPIC: A94-092 TITLE: Advanced Analytical Techniques for Determining Metal Speciation in Contaminated Soils
Point of Contact: WES

CATEGORY:

OBJECTIVE: To develop the hardware and computer software for an analytical method to measure and determine the quantity and metal species found in contaminated soils. The instrumentation should have the ability to determine the metal speciation of solid soil samples resulting in contamination down to concentrations of 1ppm, have graphic imaging capabilities, and have substantial resolution capabilities between different metals and species of these metals.

DESCRIPTION: Metal contaminated soils at military sites pose large contamination problems. Few treatment alternatives currently exist for the treatment of metal contaminated soils. For those technologies which do exist, there is a lack of understanding of effectiveness of such technologies both near- and long-term. One tool needed is the development of a solid phase soil analytical method for metals speciation. Several liquid extraction methods currently exist (commonly referred to as Sequential Extraction Methods) which attempt to identify metal species in soil. Unfortunately, problems have been identified which limit the usefulness of liquid extraction for the metal speciation in soils. Generally, species are loosely defined by the extraction procedures used to remove metal from the soils, and recent research indicates that the method itself results in substantial changes in the metal species. To overcome the shortcomings of the liquid extraction methods, other analytical techniques must be sought out. Such methods should be capable of not only identifying the quantity of metal in the soil without extraction (as is currently available with X-ray fluorescent techniques), but should also identify all species contaminating the soil at concentrations in excess of 1 ppm.

Phase I: Investigate new and innovative methods for identifying metal species in soils. Conduct limited bench scale testing to verify the feasibility of the most promising concepts. Design a prototype solid phase metal speciation system based on the bench studies. Following a design review by the Army sponsor, finalize the conceptual design.

Phase II: Construct a prototype solid phase metal speciation system based on the approved conceptual design. After construction, the instrument should be thoroughly tested on known compounds and spiked soils. Detailed design drawings with specifications and a users manual should be provided to the Army sponsor. Army personnel should be trained to utilize and interpret the data.

Potential Commercial Market: This technology will have application in the chemical analytical industry as well as industrial and engineering firms currently involved with remediation activities. Development of solid phase metal speciation technology will provide information to assist in more effective environmental clean-up activities, thus providing protection to human health and welfare.

A-10 ENGINEERING SCIENCES (I.E. ROBOTICS, DYNAMICS, STRUCTURES, MECHANICS AND CONSTRUCTION)

TOPIC: A94-093 TITLE: Alternative Engagement Technologies/Concepts Providing Low Collateral Damage/Less-Than-Lethal Dual Use Capabilities
Point of Contact: ARDEC

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate alternative measures against a variety of threats and provide a low collateral damage/less than lethal dual-use capability, eg., law enforcement type application.

DESCRIPTION: There is a need to develop non-lethal techniques and mechanisms to disrupt both human and materiel system capabilities. It will involve the combination of strategy, tactics, weapons and other devices to: conduct non-lethal operations, provide an alternative to lethal force for deterrence during peacekeeping or conflict situations, augment lethal systems and protect friendly forces against such measures. Evolving technologies offer the potential for development of weapons that can disrupt or destroy an enemy's capability without causing lethal injury, excessive property damage or widespread environmental damage. Such concepts are not new to military operations but studies indicate that greater availability of such devices can provide an added dimension/flexibility to military operations. Required capabilities include but are not limited to the following:

a. Targeting: Use of disruptive tactics will require intensive intelligence support. Information on special vulnerabilities beyond accurate location and type of structure or system will be required.

b. Lethal versus Non-lethal Effects: New measurement techniques will be required to assess the effectiveness of non-lethal weapons. This includes test methods, bio-effects, simulation/models and battlefield effectiveness. Battlefield simulation models and verification test targets will need to be broadened to account for low collateral damage, non-lethality and psychological effects.

c. Operational Capabilities - desired features:
1. Reliability
2. Logistics - minimum loss of stowed load lethality
3. Deployable - from existing weapon system
4. Peacekeeping/Contingency - dual use

d. Tactical Capabilities - desired features:
1. Tunability - lethal to non-lethal
2. Kill assurance/assessment
3. Countermeasure - non-susceptibility
4. Deployable - from existing weapon system

Phase I: Develop methodology for design, implementation and evaluation of mechanisms for applications with multi-target capability being preferred. Versatility is desirable as is the capability to select on the battlefield the desired defeat level. For malate and demonstrate concepts for specific devices including preliminary operational scenarios. Good potential for Phase II should exist. Initiate development of marketing plans for Phase III efforts and identify user interest and potential dual-use applications.

Phase II: Develop laboratory prototypes and conduct tests to evaluate performance against various threat options. Evaluate impact using war game models and simulated targets. Develop preliminary plans for applications with suitable delivery vehicles and weaponization. Complete plans for Phase III and identify sources of funding.

Potential Commercial Market: Potential for Phase III should be high. It is anticipated that there will be a large military market for some of these devices and also a large potential market with law enforcement agencies.

OSCR: These low collateral damage weapons/devices may have logistical advantages over existing weapon systems. For example, they could aid in the reduction of training costs because low collateral damage would perm it training at smaller bases. There would be reduced costs for transporting equipment and soldiers, test personnel, etc to a larger base.

TOPIC: A94-094 TITLE: Intelligent Sensor Based Robotic Control System Technology
Point of Contact: ARDEC

CATEGORY: Engineering Development

OBJECTIVE: Develop a generic multi-adaptive robotic control module and development environment for mobile manipulator systems for ammunition handling, resupply and logistics applications.

DESCRIPTION: Significant progress has been made recently in developing advanced sensor based servo control systems for high performance robotic manipulators. Specifically, a high speed 386 based multi-processor robotic control module and software development environment was developed which permits a broad range of adaptive and compliant motion control strategies to be implemented for arbitrary manipulator configurations. Extensions of this technology are required, however, to deal with fundamental problems o f mobility and base motion effect, flexible task level control, multi-sensor integration, dual arm coordination associated with fusing ammunition in a moving resupply vehicle, and depalletizing and transferring ammunition to and from resupply vehicle and loading ammunition in a moving platform environment. Technical issues of interest include robust and adaptive controls, compliant motion control, visual servo control, voice natural language interface for control, dual arm control strategies, world modeling design environment, real time, knowledge based task level control and control from moving base including path planning, navigation and obstacle detection/avoidance and component based software architectures.

Phase I: Develop methodology and algorithmic approaches to intelligent sensor based robotic control systems for applications to materiel handling and loading. Perform preliminary modeling and simulation studies to determine performance/robustness characteristics of the control laws and algorithms, real time processing requirements and sensor requirements. Provide analysis for evaluating control laws and provide control processor design and system hardware specifications.

Phase II: Develop controller hardware/software and development environment for interface with laboratory test bed manipulator systems. Develop test scenarios and scaled down mock-ups to demonstrate controller performance capabilities. Provide fully integrated prototype module with documentation source code and development environment and evaluate in laboratory tests.

Potential Commercial Market: The technology developed under this program can be utilized on any production line performing product handling, part mating and product transferring applications. Particularly, for the Army, this technology can be used in pro grams like Future Armored Resupply Vehicle (FARV-A) and Advanced Field Artillery System (AFAS) to perform ammunition fusing, handling and loading during re-supply operations.

OSCR: This technology will provide cost reductions to Army operations where elimination of operators is needed. For instance, in programs like FARV-A and AFAS, this technology will be beneficial due to its potential application to operations such as fusing, de-pelletizing and transferring of ammunition to and from re-supply vehicle.

TOPIC: A94-095 TITLE: Advanced Adaptive Weapon Control Technology
Point of Contact: ARDEC

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate low cost high performance digital servo control technology for precision fire-on-the-move applications including armor, air defense and aircraft system applications.

DESCRIPTION: Recently progress has been made in demonstrating major accuracy improvements for both aircraft and combat vehicle weapon systems using advanced digital control design techniques and LOG LTR design approaches. Further improvements in gun accuracy are anticipated through the development of improved robust nonlinear and adaptive control laws and control laws that exploit recent advances in H infinity and 11 technology permits these techniques to be implemented in high bandwidth digital servo loops required for precision gun stabilization. This project will address the broad spectrum of issues associated with the development of design tools and methodology, modeling, simulation and real time hardware/software implementation.

Phase I: Develop methodology for design and implementation of high performance robust adaptive and nonlinear control laws for precision weapon stabilization and tracking. Formulate specific control laws for nominal two input, multi output nonlinear plan t with friction, backlash, resonant modes, high impulse periodic disturbances nonlinear compliance and sensor noise. Determine performance and robustness characteristics with respect to structural and unstructured plant perturbations and provide analysis of hardware/software implementation requirements.

Phase II: Develop a fully integrated design, test and prototyping environment for advanced nonlinear and adaptive multivariable control systems. Provide a real time programmable digital control module with on-line data analysis capability and I/O capability necessary for laboratory test bed evaluation. Optimize module hardware/software and algorithm design based on test data and provide complete documentation of algorithms and hardware/software architecture.

Potential Commercial Market: This work has a very high probability of being commercialized. The methodology and design environment developed in this SBIR can be used by many industries such as hydraulic and electric motor manufactures, machine tool manufactures, process control companies, automobile and aircraft companies, robotic applications, stabilized optical sight systems, etc. Anyone who designs control systems must confront nonlinearities, parameter variations, backlash, friction and resonant modes.

OSCR: Microprocessor-based control is a low-cost independent way to implement advanced control algorithms. One of it's biggest benefits is the ability to rapidly modify the control algorithms, making it very cost effective when upgrading a weapon platform or even moving the entire system to a new applications. Nearly all of the current controllers in the Army are analog based; i.e. capacitors, op amps and resistors fixed to a circuit card. Changes are very hard to make and portability between weapon platforms is impossible. If one microprocessor could be used for each servo control application in the Army with only the code being modified, the cost savings could be large. Another cost saving aspect of this work is the ability to get very high performance out of systems with backlash, friction, resonant modes, etc. What this means is that the Army can use a low-cost microprocessor-based Adaptive-Nonlinear Controller rather than buying new, very precise (and expensive) mechanical hardware or retrofitting existing systems to eliminate the nonlinearities, i.e. improve the performance with better algorithms and software rather than hardware.

TOPIC: A94-096 TITLE: Navigation Issues for Low Cost Competent Munitions
Point of Contact: WTD

CATEGORY:

OBJECTIVE: The objective is to develop novel navigation and inertial measurement concepts for LCCM.

DESCRIPTION: The development of Low Cost Competent Munitions (LCCM) presents a number of technology challenges. The ability of the munition to "know" its position and velocity in an inertial coordinate system is critical. The munitions may be spinning at high rates (200 RPS) or rolling at slow rates (0 to 35 RPS). The effectiveness of artillery is measured by the dispersion about the target. LCCM offers to reduce (not eliminate) the dispersion. Many of the applications will be for gun-launched projectiles where the launch environment will be harsh (potentially 20,000'g or more). Concepts must have promise for small, rugged, and low cost solutions.

Phase I: Analysis and evaluation of novel navigation concepts for LCCM. Develop and refine the plan for Phase II.
Phase II: Design and fabricate hardware for a feasibility demonstration.
Phase III: Provide hardware and technological expertise for a LCCM feasibility demonstration.

Potential Commercial Market: The market potential for a low cost IMU is small but significant. Typical applications are stabilizing optics in cameras, camcoders and binoculars; navigation of robots; and small boat navigation.

TOPIC: A94-097 TITLE: Computational Modelling Systems for Aerodynamic Design and Evaluation of Rotorcraft Concepts

Point of Contact: AVRDEC

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate new and innovative computational methods that will enable reliable advanced aerodynamic design and evaluation of rotorcraft configurations by engineering personnel. The required methods must predict the performance, aerodynamic loading and acoustic properties of rotorcraft. Concepts developed must be suitable for use in the design environment and provide a common analysis medium for industry and Army conceptual analysis and evaluation teams.

DESCRIPTION: The Army rotorcraft fleet has experienced steady growth in operational needs concerning payload, range and performance - culminating in the need to study extensive fleet upgrades or even new aircraft. Such studies require analysis methods with the ability to perform rapid aerodynamic computations whose reliability will minimize or obviate the need for costly and lengthy testing and permit the expeditious evaluation of competing alternatives. This solicitation is for such an analysis system that can integrate a sufficiently wide variety of flows, provide the analyst with options to vary the required fidelity of the model and be fast enough for practical engineering usage.

The required analyses must encompass all the elements of flow physics required to predict rotor performance, loading and acoustic behavior. These flow elements include high-speed or high-lift induced transonic flows; inflow or transonic-induced unsteadiness; wake formation, convection and interaction; steady and unsteady separation effects: accurate drag prediction; components interference effects. It is understood that some flow effects - especially stall - may require the use of empirical models. However, the analysis must be based on a core solver that predicts the essential establishment and convection of the rotor wake both in the near-blade compressible flow field and in the distant wake. This basic rotor/wake inviscid solver must be coupled to ancillary solvers that provide viscous corrections for prediction of profile power and stall onset. It is permissible to use semi-empirical models for post-stall behavior, however full stall-flow solvers of unusual promise are desirable. A more important feature is the ability to couple the flow to trim and blade deformation solver for the high-fidelity prediction of rotor behavior. In summary, a fast and accurate set of CFD analyses - integrated with a set of versatile surface and outer boundary conditions - are required that provide a wide and readily accessible range of analysis options to an engineering user. An essential feature of the analysis tool is that it be possible to run the basic flow solver on engineering work stations in order that widely separated Army analysts can perform the same or complementary computations. The analysis must be completely portable. It is also required that it be possible to "turn on" advanced levels of modelling as they are required - beginning with the inviscid rotor/wake behavior of a rotor with specified motion and working up in stages to a viscous rotor solution with a completely unconstrained blade motion.

Phase I: Investigate, identify and implement new and innovative solution methods for the fast prediction of rotor-wake flows and/or innovative means for the integration of all the necessary flow effects required to constitute a working model of a rotor. Demonstrate a basic flow method (a highly efficient model of inviscid, transonic, rotor-wake behavior) and a means to incrementally add increasing levels of physical fidelity as these are required for the prediction of critically important problems. Demonstrate that the basic model is compatible with practical work-station application and that the model is easily portable to larger machines as the physical fidelity of the solution grows. The model shall be shown to predict the performance of rotors in hover and the loading of rotors in forward flight. It should be demonstrated that the basic method has the ability to readily predict rotor-wake interaction effects and include the results of these in an acoustic analysis. The ability to couple the effects of blade motion and deformation shall also be demonstrated.

Phase II: Implement the full capabilities implied in the phase I demonstrations. Implement an accurate inner Navier-Stokes solver and test for ability to predict profile power and stall onset with accuracy. Couple the full blade wake-solution to a suitable trim and structural deformation code and demonstrate convergence. Implement a stall model. Couple a linear acoustic model. Construct a complete computational model for one or more Army rotorcraft requiring major upgrade studies.

Phase III: Prepare training documentation. Deliver the model to industrial design/engineering and Army engineering and evaluation personnel. Demonstrate the users ability to predict critical rotorcraft characteristics - such as hover performance or BVI noise - and to perform computational parametric studies of rotorcraft geometry on these and transfer the analyses and results to remote co-users. Demonstrate application of the code as a medium of technical exchange between remote users.

Potential Commercial Market: This technology will have application to the general prediction of all aviation problems wherein the aircraft is influenced by wake behavior. This will be especially important to the rotorcraft analysis and operations study market and an essential support to U.S. helicopter industry, which increasingly relies on outside sources for it's basic analysis methods.

TOPIC: A94-098 TITLE: Application of Acoustic Sensors for Helicopter Health Monitoring
Point of Contact: AVRDEC

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate health monitoring of rotorcraft mechanical components using acoustic sensors.

DESCRIPTION: Monitoring of helicopter mechanical components using vibration has been successful and is well documented. Using high frequency acoustical methods may hold promise and ease problems with system implementation or retrofit on existing airframes. Acoustical methods need to be evaluated for application to on-aircraft real time monitoring. Under this program the ability to extract the necessary signals from the general background noise and make accurate assessment of component health would be demonstrated. Data generated should not require post flight processing or analysis. Processing requirements, location effects and implementation issues would be addressed.

Phase I: A system for onboard monitoring of an aircraft critical component or components shall be designed. Various acoustical techniques shall be evaluated for the proposed application. Failure modes and signatures of the component will be defined and the effectiveness of acoustical detection techniques estimated. Detection levels as well as the time remaining until failure will be considered. Requirements for size, weight, and ruggedization for both sensor and processing units shall be addressed.

Phase II: The system designed in Phase I shall be prototyped and bench tested. This phase will fabricate and assemble the hardware necessary for testing. Multiple acoustical monitoring techniques shall be programmed for evaluation. Testing of the system will be conducted using an appropriate test stand or rig using seeded faults. Effectiveness of the various techniques will be determined.

Phase III: Design and qualify a production system suitable for application to both military and civil aircraft industries. This could take the form of a stand alone system or a sensor and analysis technique to be inserted in a integrated aircraft condition monitoring package.

Potential Commercial Market: This technology would have application to commercial aircraft. Techniques could be applied to any similar high cost mechanical system.

TOPIC: A94-099 TITLE: Compact Infrared Zoom Lens Design
Point of Contact: MICOM

CATEGORY: Engineering Development

OBJECTIVE: To design and build a compact infrared zoom lens with size, weight, and volume constraints suitable for use in guided munitions.

DESCRIPTION: Guided munitions technology has progressed to the point of a need having been developed for compact and lightweight infrared zoom lenses. Typically, missile seekers use a wide field of view during the target search and acquisition phase, then switch to a narrow field of view for terminal homing. The sudden change of aspect within the field of view of the seeker when the switch is made from wide to narrow creates electronic and logic design complexities within the seeker design and a momentary adjustment period if a human is in the loop. A zoom lens would eliminate the problems associated with the sudden change in the seeker field of view. Typical infrared zoom lens designs are large and complex and usually offer a limited range of magnification ratios, and are not suitable for guided munitions applications; a compact and lightweight design would be suitable.

Phase I: Design an infrared zoom lens with dimensions less than 150 millimeters by less than 75 millimeters that operates in the 3-5 micron band, with a zoom range of 4:1, focal lengths from approximately 50-200 millimeters with constant f/4.5 and a field of view of approximately 5 degrees to 20 degrees. If necessary, this will include a survey of the manufacturing methods available for production. An optical and thermal analysis of the design will be conducted along with a manufacturing tolerance evaluation.

Phase II: Manufacture an infrared zoom lens based on the design provided in Phase I using suitable infrared materials. Design, manufacture and test the mechanical mounts and motion control hardware for the lens, align the zoom lens system and evaluate it s optical performance at selected points that span the full field of view and range of zoom.

Potential Commercial Market: A compact infrared zoom lens has potential use in any commercial market associated with infrared sensing such as surveillance and remote sensing when size and weight restrictions are necessary or cost effective.

TOPIC: A94-100 TITLE: In Bore Projectile Speed Measurement System for Use in Electromagnetic Launchers
Point of Contact: TECOM

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a system capable of measuring projectile speed continuously from first motion until muzzle exit inside of electromagnetic launchers during gun testing. Concepts developed must work in harsh environments of high electro magnetic noise, plasma gas and mechanical shock and vibration, and be able to recover the signal in the event of transient data dropouts.

DESCRIPTION: Electromagnetic launchers, varying in length up to 10 meters long, and with round and square bores up to 90 millimeters are being developed and tested throughout the world, and on a tri-Service level in the United States. A considerable effort is being made to develop projectiles for these guns. Current in-bore projectile speed measurements are made using B-dot probes placed discretely along the guns. The data are prone to noise induced by the harsh electromagnetic environment, and the spacing between the sensors is very large considering the projectile speed of 5 km/sec and rapid acceleration. A system based on a doppler laser, that is immune to the electromagnetic noise, and capable of performing the desired measurements is desired. The laser system must be able to recover the signal in the event of dropout due to transient bursts of plasma gas leakage past the projectile. The speed information must be updated on the microsecond level, and speed measurement must be accurate to within 10 meters/sec at maximum projectile speed to assure good data. Smooth projectile speed information, updated often and with high accuracy, can be used to calculate projectile position and acceleration in the gun, which could be used to estimate the forces on the projectile.

Phase I: Investigate new and innovative ways to capture, process, save and analyze in-bore projectile speed measurements. The investigator will obtain all currently available information pertinent to this task and determine how to solve the many technical problems associated with solving the speed measurement problem. Phase I should demonstrate that the concept will be able to recover the signal in the event of dropouts due to transient signal loss, and that the system will work in an existing electromagnetic launcher without signal degradation due to the insulators between the rails of the gun and the high electromagnetic noise in and around the gun during testing. The investigator should also demonstrate that the system can update speed information every 30 microseconds and be accurate to within 10 meters/sec when projectile speed is from 0 to 5 km/sec.

Phase II: Implement the new concepts into a working system that is easy to filed and align, withstands the shock and vibration of conventional and electromagnetic guns, and is portable and reliable.

Potential Commercial Market: The technology required to develop a fielded system is applicable to various gun manufacturers such as the makers of small arms. The technology required to process laser doppler information quickly enough to solve this problem has application in advanced spread spectrum communications systems such as digital cellular telephones. Frequency hopping cellular phones require very sophisticated diagnostic tools which are currently not available. Law enforcement agencies need this capability to monitor frequency hopping cellular phone conversations.

NAVY

Proposal Submission

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research. The Navy SBIR Program Manager is Mr. Vincent D. Schaper. Inquiries of a general nature may be brought to the Navy SBIR Program Manager's attention and should be addressed to:

Office of Naval Research
ATTN: Mr. Vincent D. Schaper
ONR 4130 SBIR
800 North Quincy Street
Arlington, VA 22217-5660
(703) 696-4286

SBIR proposals shall not be submitted to the above address and must be received by the cognizant activities listed on the following pages in order to be considered during the selection process.

The Navy's SBIR program has been redirected for FY 1994 from one that was integrated with the needs and requirements of the Navy through engineering development headquarters activities to one that is primarily integrated with the needs and requirements of the Navy through its science and technology centers while providing "dual-use " topics. The program is a balance between science (S) and technology (T) areas that the Navy has identified as necessary to meet its mission responsibilities. While a total of 31 S&T areas has been identified (see Table 1), all of these areas may not be funded equally during the two annual DOD SBIR solicitations in which the Navy participates. The Navy will fund topics according to a priority it has established to meet its mission goals and responsibilities.

This solicitation contains 126 technical topics to meet the requirements of the Navy's mission and PL 102-564 to which small R&D businesses may respond. The Navy will provide potential awardees the opportunity to reduce the gap between phases I & II by providing a $70,000 Phase I feasibility proposal award with a $30,000 Phase I Option, or small businesses may elect to just submit a Phase I proposal for $100,000. If small businesses choose the former, the Option effort should form the initial part of the Phase II work. Only companies whose Phase II proposal has been recommended for award will be funded for the Phase I Option. Therefore, those who have finished or almost finished their "Phase I feasibility" portion should submit their Phase II proposal with a "demonstration Phase II" portion and an option. The Phase II proposal package should contain a plan of how the proposer will commercialize the technology to the government (and the private sector) in addition to the technology demonstration portion of the proposal. At the end of the "demonstration Phase II" portion, a determination will be made by the Navy as to whether the proposer has satisfied the commercialization plan sufficiently for the government to fund the "Phase II option" portion of the proposal. The Phase II option should address the further R&D or test and evaluation aspects of the proposal. The total Phase II funding will not exceed $750,000 with 80% going to the "demonstration Phase II" portion and 20% for the "option Phase II" portion. Proposed options for Phase I should fit within the 25-page limit, which is specified in the "PROGRAM DESCRIPTION" section of this solicitation. The requirements for the Phase II proposal will be given to companies at the time of Phase I award.

Selection of Phase I proposals will be based upon technical merit; evaluation procedures and criteria are discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only those proposals considered to be of superior quality will be funded.

TABLE 1. NAVY MISSION CRITICAL SCIENCE AND TECHNOLOGY AREAS

TECHNOLOGY	SCIENCE
Aerospace Propulsion and Power	Computer Sciences
Aerospace Vehicles	Mathematics
Chemical and Biological Defense	Cognitive and Neural Sciences
Command, Control, and Communications	Biology and Medicine
Computers	Terrestrial Sciences
Conventional Weapons	Atmospheric and Space Science
Electron Devices	Ocean Science
Electronic Warfare	Chemistry
Environmental Quality and Civil Engineering	Physics
Human-System Interfaces	Electronics
Manpower and Personnel	Materials
Materials and Structures	Mechanics
Medical	Environmental Science
Sensors	Manufacturing Science
Surface/Undersurface Vehicles	
Software	
Training Systems	

NAVY SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Submitting Proposals on Navy Topics

Phase I proposal (5 copies) should be addressed to:

	Administrative SBIR Contact
Topic Nos. N94-124 through N94-166	
Mail/Handcarry Address: Office of Naval Research Attn: ONR 36D Room 604 SBIR Program, Topic No. N94-____ 800 N. Quincy Street, BCT #1 Arlington, VA 22217-5660	Mr. Douglas Harry (703) 696 4287
Topic Nos. N94-167 through N94-171	
Mail Address: Commander Marine Corps Systems Command Attn: Code AW, SBIR Program, Topic No. N94-______ Quantico, VA 22134-5010	Mr. Joseph Johnson (703) 640-4801
Handcarry Address: Commander Marine Corps Systems Command Attn: Code AW, SBIR Program, Topic No. N94-______ Building #3097, 2nd Deck Quantico, VA 22134-5010	
Topic Nos. N94-172 through N94-176	
Mail/Handcarry Address: Commander Naval Air Systems Command Attn: Code AIR-05TE2, SBIR Program, Topic No. N94-______ 1421 Jefferson Davis Highway Jefferson Plaza #1, Room 444 Arlington, VA 22243-5003	Ms. Cathy Nodgaard (703) 692-7393

Topic Nos. N94-177 through N94-185

Administrative
SBIR Contact

Mail Address:
Commanding Officer
Naval Air Warfare Center
Aircraft Division Warminster
Attn: Code 01B, SBIR Program, Topic No. N94-______
P.O. Box 5152
Warminster, PA 18974-0591

Ms. Carol Van Wyk
(215) 441-2375

Handcarry Address:
Commanding Officer
Naval Air Warfare Center
Aircraft Division Warminster
Attn: Code 01B, SBIR Program, Topic No. N94-______
Street Road/Jacksonville Road
Warminster, PA 18974-0591

Topic No. N94-186 and N94-187

Mail Address:
Commanding Officer
Naval Air Warfare Center
Aircraft Division Lakehurst
Attn: Code 02T (POD), SBIR Program, Topic No. N92-______
Lakehurst, NJ 08733-5000

Mr. Pete O'Donnel
(908) 323-7566

Handcarry Address:
Commanding Officer
Naval Air Warfare Center
Aircraft Division Lakehurst
Attn: Code 02T (POD), SBIR Program, Topic No. N92-______
Bldg. #342
Lakehurst, NJ 07833-5000

Topic No. N94-188

Mailing Address:
Commander
Naval Air Warfare Center Aircraft Division
Flight Test and Engineering Group
Attn: Code CT24, SBIR Program, Topic No. N94-192
Patuxent River, MD 20670-5304

Mr. Curt Snyder
(301) 826-1144

Handcarry Address:
Commander
Naval Air Warfare Center Aircraft Division
Flight Test and Engineering Group
Attn: Code CT24, SBIR Program, Topic No. N94-192
Building #304/3169
Patuxent River, MD 20670-5304

Topic Nos. N94-189 through N94-192

Administrative
SBIR Contract

Mailing/Handcarry Address:
Commander
Naval Air Warfare Center
Weapons Division
Attn: Code P3402, SBIR Program, Topic N94-_____
512 9th Street, Building 50, Room 1076
Point Mugu, CA 93042-5001

Mr. Eugene Patno
(805) 989-9209

Topic Nos. N94-193 through N94-195

Mail/Handcarry Address:
Commanding Officer
Naval Training Systems Center
Attn: Code PDR2, SBIR Program, Topic No. N94-_____
12350 Research Parkway
Orlando, FL 32826-3224

Ms. Janet Weisenford Healy
(407) 380-8276

Topic Nos. N94-196 through N94-207

Mail/Handcarry Address:
Commander
Naval Sea Systems Command
Attn: Code 03R5E, SBIR Program, Topic No. N94-_____
Crystal Plaza #5, Room 924
2211 Jefferson Davis Highway
Arlington, VA 22242-5160

Mr. William Degentesh
(703) 602-3005

Topic Nos. N94-208 through N94-214

Mail Address:
Commander
Naval Surface Warfare Center
Carderock Division
Attn: Code 0112, SBIR Program, Topic No. N94-_____
Bethesda, MD 20084-5000

Mr. Frank Halsall
(301) 227-1094

Handcarry Address:
Commander
Naval Surface Warfare Center
Carderock Division
Attn: Code 0112, SBIR Program, Topic No. N94-_____
Building #1, Room 216M
Bethesda, MD 20084-5000

Topic Nos. N94-215 through N94-217

Administrative
SBIR Contact

Mail Address:
Commander
Naval Surface Warfare Center
Dahlgren Division
Attn: Code D-45, SBIR Program, Topic No. N94-_____
Silver Spring, MD 20903-5000

Mr. Donald Wilson
(301) 394 -1279

Handcarry Address:
Commander
Naval Surface Warfare Center
White Oak Detachment
Attn: Code D-45, SBIR Program, Topic No. N94-_____
Building #1, Reception Room
Silver Spring, MD 20903-5000

Topic No. N94-218

Mail Address:
Commander
Naval Surface Warfare Center
Dahlgren Division/Costal Systems Station
Attn: Code L03B, SBIR Program, Topic No. N94-222
Panama City, FL 32407-5001

Mr. Ed Linsenmeyer
(805) 234-4161

Handcarry Address:
Commander
Naval Surface Warfare Center
Dahlgren Division/Costal Systems Station
Attn: Code L03B, SBIR Program, Topic No. N94-222
Building #110, Room 2C2
Panama City, FL 32407-5001

Topic No. N94-219

Mail Address:
Commander
Naval Undersea Warfare Center
Detachment New London
Attn: Code 102L, SBIR Program, Topic No. N94-223
New London, CT 06320-5594

Mr. Jack Griffin
(203) 440-4116

Handcarry Address:
Commander
Naval Undersea Warfare Center
Detachment New London
Attn: Code 102L, SBIR Program, Topic No. N94-223
Building #80
New London, CT 06320-5594

Topic Nos. N94-220 through N94-230

Administrative
SBIR Contact

Mail/Handcarry Address:
Commander
Space and Naval Warfare Systems Command
Attn: Code SPAWAR OOK, SBIR Program, Topic No. N94-_____
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DEPARTMENT OF THE NAVY TOPIC DESCRIPTIONS

OFFICE OF NAVAL RESEARCH

N94-124 TITLE: Automatic Target Recognition

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Mathematics/Sensors

OBJECTIVE: To develop new mathematical techniques for the representation of objects subject to random variation in form with respect to a prototype, and to employ these techniques in optimal target recognition problems.

DESCRIPTION: Mathematical models of objects subject to random variation in form with respect to a prototype can be used to build in prior real world knowledge specific to the object recognition application at hand, and thus improve the performance of target recognition systems of Navy interest. In recent years the theories of stochastically deformable templates and stochastic mathematical morphology have shown great promise for the representation of objects of randomly variable shape and form. The goal is to further develop the theory of stochastic object representation and to exploit these models in enhanced target recognition algorithms. Typical applications of Navy interest include radar, side scan sonar, infrared, LIDAR, and a variety of target types including minefield imagery, ships, aircraft, among others. Dual use applications include automatic recognition of handwritten characters and medical image analysis.

PHASE I: Demonstrate the utility of stochastic geometric approaches to object recognition in automatic target recognition applications.

PHASE II: Apply the techniques developed in Phase I and create prototype software to the point of feasibility demonstration and test on real image data sets.

PHASE III: Commercialize improved software systems for automatic target recognition, optical character reader, and medical imaging applications.

COMMERCIAL POTENTIAL: For optical character recognition, medical imaging, and industrial part tracking applications.

N94-125 TITLE: Giant Magnetoresistance Sensors

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Electronics/Sensors

OBJECTIVE: Develop new sensor devices based on the novel giant magnetoresistance properties of multilayered magnetic metal films for use in motion detection and for sensitive detection of magnetic fields.

DESCRIPTION: New multilayered magnetic metal films exhibit a giant magnetoresistance effect which can be exploited in a variety of new applications which require sensitivity to magnetic fields. High sensitivity means smaller devices, and the materials provide increased sensitivity with rugged structure, insensitivity to temperature and can be developed with a simple materials technology. Military applications include mine detection, metal detection and navigation. Other interests include sensors for linear and angular motion detection with increased dynamic range and linearity.

PHASE I: Develop models for sensor operation and fabrication, including operating parameters and estimated performance.

PHASE II: Develop prototype sensors and appropriate technology in collaboration with commercial or government laboratories in anticipation of transfer to a production facility.

PHASE III: Transfer materials and modeling technology to commercial production facilities.

COMMERCIAL POTENTIAL: Small, rugged, high performance sensors will be used in a variety of motion detection systems requiring cheap and versatile devices which are compatible with electronic signal processing. High sensitivity magnetic field sensing will also find many applications including magnetic data storage and readout systems.

N94-126 TITLE: SQUID Detection Systems

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Materials

OBJECTIVE: To design, build, and evaluate Superconducting Quantum Interference Device (SQUID) detection systems employing high temperature (HTS) materials and analog or digital circuitry for use in corrosion detection and/or Non-Destructive Evaluation (NDE). The systems should be field deployable.

DESCRIPTION: The development of HTS SQUIDs and associated electronics has progressed so that a field operable system can be designed, built, and evaluated for potential use in the Navy to detect hidden corrosion or other types of material flaws. The system should consist of a sensor or sensor array designed for rapid data acquisition. The system could be passive or employ a current or a magnetic field source for active detection. A cost effective, field deployable concept should be the ultimate goal of the system.

Phase I: Design an HTS SQUID system, of sensor(s) and compatible electronic circuitry. Calculate anticipated system sensitivity and describe mode of operation for detection of corrosion or material flaws.

Phase II: Construct an HTS SQUID system and perform laboratory evaluation of performance including sensitivity, noise, and response or slew rate. The system will be delivered to the Navy for operational testing and evaluation.

Phase III: Multiple systems will be built for testing and demonstration.

COMMERCIAL POTENTIAL: Wide use in aircraft industries, manufacturing industries, transportation industries, etc.

N94-127 TITLE: Robust Cold Cathodes for Displays and Millimeter Wave Amplifiers

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Electronic Warfare

OBJECTIVE: Develop robust cathodes that (1) are not subject to the built-in wear-out mechanism that amperes x hours is a constant and (2) that are not easily poisoned by poor vacuum conditions.

DESCRIPTION: New semiconducting materials exhibiting bandgaps greater than 5.4 eV generally (1) exhibit Negative Electron Affinity (NEA) and (2) possess chemical surface bonds of sufficient strength to impede chemisorption of impurities (and thus poisoning). Superlattice-emitted electrons with energy spreads of less than 0.05 Ev will significantly reduce noise in microwave/millimeter wave vacuum tubes and enable electron microscopy improvements. Emphasis shall be placed on (1) enhancing the reproducibility and uniformity of cold cathodes (CC), (2) demonstrating their robust nature, and (3) demonstrating significant improvement in reducing energy spread to below 0.05 Ev.

PHASE I: Demonstrate cold cathode efficacy of selected material.

PHASE II: Demonstrate and optimize the resistance of the CC to poisoning, determine its operating life as a function of emitted current density, and demonstrate energy spread reduction.

PHASE III: Demonstrate the use of a cold cathode in a millimeter wave traveling wave tube (TWT) amplifier or as a ballasted 2-D array of emitters for a large area (e.g., >14" diagonal) flat panel display.

COMMERCIAL POTENTIAL: This concept provides the potential for a U.S.-dominated $10B/year flat panel color display market.

N94-128 TITLE: Super-High-Density Non-Volatile Memory

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Electron Devices

OBJECTIVE: Develop a totally new approach to super high density, non-volatile, rapid and random access digital memory.

DESCRIPTION: New means of rapidly depositing/repositioning atomic particles in extremely dense configurations coupled with quantum well/optical readout technology engenders a new digital memory concept for a terabit memory that is not vulnerable to power outage, replaces both RAM and mechanical storage, and is low power. This non-volatile aspect plus the low power aspect are both expected to impact avionics and shipboard systems currently subject to frequent power outages. Emphasis is placed on (1) demonstrating concept validity, (2) demonstrating absence of wear-out mechanisms, and (3) demonstrating super high density.

PHASE I: Demonstrate 64 bit non-volatile memory

PHASE II: Demonstrate 64 kbit memory; demonstrate resistance to G forces; demonstrate random access.

PHASE III: Design terabit memory; demonstrate 4 Mbit memory; demonstrate rapid (e.g., 10 nanosecond) access for both read and write.

COMMERCIAL POTENTIAL: $10B/yr commercial DRAM and hard drive original equipment and replacement market. Eliminate hard drives from portable computers.

N94-129 TITLE: 4-D Oceanographic Instrumentation

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Ocean Sciences

OBJECTIVE: To develop innovative instrumentation to measure oceanographic and/or meteorologic parameters.

DESCRIPTION: Innovative sensors and measurement techniques are solicited to obtain marine atmospheric and oceanographic variables (eg acoustical, optical, physical, biological, chemical, and geophysical) in 3-D space and time. The emphasis is on (1) novel approaches and concepts for measuring multiple parameters coherently in 4-D; (2) new methods of measuring turbulent fluxes, acoustic wavefields, or fluid motion of multi-phase mixtures (e.g. water/bubbles/sediments/biologics). Instruments can be individual towed/tethered sensors, elements in arrays, or suites of instruments on unmanned vehicles/platforms to cite a few examples. Lost cost, reliable and possibly expendable sensors/components are particularly desirable. Full depth capability is desired in instrumentation planned for subsurface use. Particular capabilities are sought for bubble and spray population measurements, dynamic void fractions in water, small scale turbulent fluxes of heat mass & momentum, and near bottom sediment fluxes.

PHASE I: The Phase I effort should provide a description of exactly what will be measured and to what accuracies and coherence as well as providing the design concept for achieving the measurements. Phase I should produce a proof of concept by demonstrating untested concepts or instruments.

PHASE II: The Phase II effort would develop hardware and demonstrate feasibility via laboratory and/or field testing (as coordinated with ongoing ONR efforts).

PHASE III: Phase III would transition the instruments to ocean science researchers, ocean monitoring systems and operational DOD systems.

COMMERCIAL POTENTIAL: New instruments can be used in commercial ocean monitoring systems.

N94-130 TITLE: Platforms for 4-Dimensional Environmental Sensing

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Sensor

OBJECTIVE: To develop/adapt airborne/underwater remote vehicles to sensors for measuring 4-dimensional environmental parameters.

DESCRIPTION: Unmanned underwater vehicles (UUVs) and aerial vehicles (UAVs) have been developed and used for numerous applications. The difficulty and affordability of 4-dimensional environmental sensing strongly suggests application of low cost remotely controlled or autonomous vehicles and platforms for environmental parameter measurements. A vehicle/sensor system integration analysis is desired to identify the compatible measurements that are possible from such platforms, the state of the art instrumentation which is required, the payload requirements versus mission, the power requirements and endurance, together with a functional description of the vehicle/platform and its control system. Particularly desired are designs which would allow undisturbed high resolution sampling of the sea floor topography, autonomous vertical profilers and surface vehicles which may be small enough to be nearly unobservable when in use.

PHASE I: The Phase I effort should provide descriptions of the sensor/platform system and its measurement capabilities together with analysis indicating why a remotely controlled platform is scientifically/fiscally superior to the present methods of making such measurements.

PHASE II: The Phase II effort would develop hardware and demonstrate feasibility via laboratory and/or field testing (as coordinated with ongoing ONR efforts).

PHASE III: Phase III would transition the instruments to ocean science researchers, ocean monitoring systems and operational DOD systems.

COMMERCIAL POTENTIAL: Low cost unmanned vehicles have many commercial monitoring applications.

N94-131 TITLE: Coastal Ocean Observing Systems

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Ocean Sciences

OBJECTIVE: Development of innovative observing systems to measure oceanographic and meteorological parameters in and above the coastal ocean.

DESCRIPTION: Innovative instruments and measurement techniques are solicited to obtain oceanographic and atmospheric (acoustical, optical, physical, biological, chemical and geophysical) variables in three dimensional space and time in the coastal environment via in-situ or remote sensors. The coastal ocean is defined as the region above the continental shelf extending from the surf zone to the upper continental slope (typically from the swash line to a few 100 m depth). Important differences between the coastal and open ocean include: short spatial and temporal scales of dominant phenomena, proximity of the surface and bottom, proximity of land, poor water clarity, high biological activity, high acoustical background noise, intense fishing, etc. Many of these differences offer potential for innovative observational techniques, or for creative adaptation of existing techniques. Examples include, but are not limited to, bottom-mounted instrument systems, land or air-based remote sensing, shore-launched autonomous vehicles, and sensors for moorings or drifters. Systems with low-cost, high reliability, high efficiency, small size, and low-power consumption and/or expendable sensors and components are highly desirable. Telemetry in real time should be considered where appropriate and fusion of in-situ and remotely observed data is also desirable.

PHASE I: The Phase I proposal should provide a description of exactly what will be measured and to what accuracy and resolution, as well as providing the design concept for achieving the measurements. Phase I should produce a proof of concept by demonstrating untested concepts or instruments.

PHASE II: Phase II would develop hardware and operationally demonstrate the system via lab or field testing.

PHASE III: Phase III would transition the prototype systems to commercial production for use in ocean science research, coastal monitoring systems, and commercial applications.

COMMERCIAL POTENTIAL: Such instrumentation would have great private sector significance.

N94-132 TITLE: Compact Remote Sensing Systems for Coastal Environments

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Ocean Sciences

OBJECTIVE: To develop compact sensors that can be deployed on small, remotely-piloted aircraft for measuring the electromagnetic properties (optical, microwave, infrared and thermal) of coastal environments.

DESCRIPTION: Innovative plans are solicited to develop scanners/detectors to remotely sense the electromagnetic properties (e.g. optical, microwave, near infrared, and/or thermal) of coastal and estuarine environments (water, the low-level atmosphere and coastal land). Emphasis should be placed on small, portable, multi-sensor packages that may be deployed on Remotely Piloted Aircraft. Low-cost, reliable systems are particularly desirable that are capable of storing data internally (downloadable to PCs after retrieval) and/or transmitting data to a ground station, including platform location (altitude, latitude/longitude and time). Either exploitation/adaptation of existing technologies or new developments particularly suited to the coastal regime are encouraged.

PHASE I: The Phase I proposal should provide a description of exactly what will be measured and to what accuracy and resolution, as well as providing the design concept for achieving the measurements. Phase I should produce a proof of concept by demonstrating untested concepts or instruments.

PHASE II: Phase II would develop hardware and operationally demonstrate the equipment via lab or field testing.

PHASE III: Phase III would transition the prototype instruments to commercial production for use in ocean science research, coastal monitoring systems, and commercial applications.

COMMERCIAL POTENTIAL: Private sector applications include climate forecasting and long-range prediction models for coastal industries.

N94-133 TITLE: Miniaturized Chemical Oceanographic Instrumentation

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Ocean Sciences

OBJECTIVE: Develop miniaturized chemical oceanographic instrumentation for deployment from towed arrays, moorings, aircraft and small autonomous vehicles.

DESCRIPTION: Innovative miniaturized chemical oceanographic instruments that take advantage of recent developments in chemical and biological technology and in micro-machining are needed to permit cost-effective collection of environmental chemistry data on appropriate time and space scales. The instruments should be capable of determining fine-scale chemical gradients in the ocean or marine atmosphere and be capable of telemetering the data. The emphasis is on (1) novel approaches and concepts for measuring multiple chemical variables; (2) Small, low-power instruments that can be towed, tethered, or incorporated into the sensor suite of small autonomous underwater vehicles or aircraft and (3) Low cost, reliable and/or expendable devices. Full depth capability is desired in instrumentation planned for subsurface use.

PHASE I: Design instrument and perform proof of concept testing.

PHASE II: Develop, test and operationally demonstrate the analytical system in the laboratory and in the field.

PHASE III: Initiate production of hardware for both commercial and military monitoring of chemical oceanographic parameters.

COMMERCIAL POTENTIAL: Applications include environmental monitoring and monitoring chemical and biochemical production facilities.

N94-134 TITLE: Remote Probing of Marine Atmospheric Storms for Assimilation

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Ocean Sciences

OBJECTIVE: Define/develop innovative remote sensing techniques which can obtain details on the structure and dynamics of storms that can be assimilated into numerical models to improve forecasts in real-time.

DESCRIPTION: The structure and dynamics of severe marine storms and their interaction with their mesoscale and synoptic environment determines their evolution, propagation, and decay. An opportunity exists for defining new, innovative remote sensing techniques which can obtain details on the structure and dynamics of storms at sea together with their surrounding environment. The parameters to be obtained remotely are likely to be combined with numerical models, so that the combined model derived data bases combined with satellite inverted remote sensing signatures will greatly advance our scientific understanding and lead to dramatically improved operational predictions. Issues to be addressed are likely to include: innovative use of existing satellite sensors either in operational use or under development; data assimilation of satellite imagery into existing numerical atmospheric models; and/or the development of new innovative remote sensing techniques which capture processes and/or parameters currently unobtainable with existing sensors and systems.

PHASE I: The Phase I proposal should provide a feasibility description of exactly what will be measured and to what accuracy and resolution, as well as providing the design concept for achieving the measurements. Phase I should produce a proof of concept by demonstrating untested concepts or instruments.

PHASE II: The phase II effort would include a more detailed proof of concept and perhaps include an operational test.

PHASE III: Phase III would transition the prototype instruments to commercial production for use in ocean science research, atmospheric monitoring/prediction systems, and commercial applications such as atmospheric monitoring.

COMMERCIAL POTENTIAL: Private sector applications include climate forecasting and long-range prediction models for coastal industries.

N94-135 TITLE: Nonlinear Optical Materials for Hybrid Semiconductor Optoelectronic Integrated Circuits

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Electron Devices

OBJECTIVE: Prepare organic 2nd order nonlinear optical (NLO) materials for incorporation into silicon/organic integrated optical modulators.

DESCRIPTION: Small scale applications such as optimal devices incorporating optical fiber interconnection technology for applications such as chip-to-chip interconnections would combine organic NLO materials and silicon or gallium arsenide semiconductors into hybrid integrated optical circuits (HIOC). An attractive approach for manufacturing HIOCs (utilizing materials compatible with current IC manufacturing) is large-hyperpolarizability chromophores in or bound to high temperature polymer matrixes (with poling). The critical process that limits HIOC device performance is the lifetime of the chromophore/polymer during chip bonding and the long term thermal stability of the poling process. If the NLO material were intrinsically thermodynamically stable, long term HIOC device performance would also be enhanced. An NLO material that can be fabricated into an HIOC with lifetime/performance characteristics superior to existing devices is desired.

PHASE I: Demonstrate materials characteristics superior to existing NLO polymers. The NLO material should be easily fabricated into waveguides and have a high electro-optic coefficient ($\underline{r}$>20pm/V), resulting in a large electro-optic figure of merit. Intrinsic optical losses of the bulk NLO material should not exceed 1 db/cm. Scheme(s) for fabricating silicon integrated optoelectronic circuits with the new NLO materials are required.

PHASE II: Demonstrate waveguide device incorporating fast (> 500MHz) electro-optic effect. Design of new HIOC.

PHASE III: Integration of NLO polymer(s) into first generation HIOC.

COMMERCIAL POTENTIAL: Communication technology including cable TV and telecommunication networks.

N94-136 TITLE: Electrochromic Displays

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Chemistry

OBJECTIVE: Develop high readability, low cost displays for dual use applications in Naval and commercial instrumentation.

DESCRIPTION: Electrochromic information displays, like liquid crystals, are non-emissive. Unlike liquid crystals, their readability does not require polarizers and is generally independent of viewing angle. These properties make them highly legible in varying light conditions as might be found in a cockpit, for example. Electrochromic displays can also be made to exhibit open circuit memory of a display image. Evidence suggests that they can be scaled in size more cost-effectively than liquid crystals, making them suitable for large area displays. Night vision goggles are another potential application, as electrochromic displays may also be made legible selectively in the infrared. Innovations in electrochromic materials and devices are required, however, to develop displays which are multicolor and matrix addressable without sacrificing the benefits of image retention and structural simplicity. In addition, electrochromic materials with improved coloration efficiencies are required to enhance update rates and decrease power consumption. All electrochromic materials and structures, however, must begin with demonstrations of reversibility of the Faradaic reactions on which they are based.

PHASE I: Develop an electrochromic display which shows the feasibility of multicolor or matrix addressable operation.

PHASE II: Demonstrate a $100cm^2$ alphanumeric electrochromic display exhibiting at least two colors, matrix addressability of less than $1mm^2$/pixel, and reversibility of greater than 10^6 update cycles. The device will require less than 10^{-3} coulombs/cm^2 and less than one second to update, and exhibit long-term image retention in the unpowered state. Projected cost of manufacture will be less than liquid crystal displays of similar size.

PHASE III: Demonstrate a technology to be employed in specific Naval instrumentation.

COMMERCIAL POTENTIAL: Commercial applications include consumer appliances and signs.

N94-137 TITLE: Novel Methods for Synthesis of Nanoscale Powders

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Materials

OBJECTIVE: Develop novel, cost effective techniques for synthesizing nanoscale powders.

DESCRIPTION: Nanoscale powders can be synthesized by a number of techniques. When consolidated into coatings and structures,nanocrystalline materials exhibit a wide range of outstanding mechanical properties, such as enhanced wear resistance and superplasticity at relatively low temperature. The cost of these powders will be critical to efforts to exploit these materials commercially. New techniques for synthesis of nanoscale ceramic and metallic powders which can produce large quantities of material and reasonable cost will be needed.

PHASE I: Develop innovative techniques for synthesizing nanoscale powders. Characterize the resulting powders and demonstrate the feasibility of producing material with desirable properties such as purity and particle size distribution.

PHASE II: Scale up process and optimize parameters to maximize yield and control properties. Demonstrate the feasibility of large scale production and competitive cost.

PHASE III: Initiate full scale production.

COMMERCIAL POTENTIAL: New class of materials with greatly enhanced mechanical properties.

N94-138 TITLE: New Generation of Atomic Clocks

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Physics

OBJECTIVE: Develop a new generation of atomic clocks taking advantage of breakthroughs in laser cooling and trapping of atoms and ions.

DESCRIPTION: The Navy, DOD, and the commercial sector currently use atomic clocks in navigation through GPS satellites. Recent breakthroughs in laser cooling/atomic physics open the possibility of clocks that are one to three orders of magnitude more precise while at the same time being more stable, smaller and hence more portable, and cheaper. This would have major impact on navigation, guidance, and commercial sector applications.

PHASE I: Demonstrate the most likely candidate atoms and/or ions; cooling schemes; clock transitions; interrogation schemes; and laser systems to be used in the next generation atomic clock.

PHASE II: Develop, test, and operationally demonstrate a compact, robust, and stable atomic clock with precision at least an order of magnitude improved over those currently flying in GPS satellites.

PHASE III: Develop usable compact clocks for applications such as GPS satellites.

COMMERCIAL POTENTIAL: Compact atomic clocks of ultra-high precision will have direct benefit to consumer-oriented navigation product ranging from on-board maps in cars to route selecting software based on traffic density, to hand-held displays of current location (e.g., for use when backpacking or visiting an unfamiliar city).

N94-139 TITLE: Stochastic Resonance Detectors

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Physics

OBJECTIVE: Develop detectors which operate on the principal of stochastic resonance.

DESCRIPTION: The detection of signal in the presence of noise plays a key role in meeting many DOD requirements in many areas including surveillance, and strike warfare. This task is difficult when the signal is weak and the signal-to-noise ratio is less than one. Stochastic resonance is a newly discovered phenomenon where a detector is operated in a manner that the addition of sufficient noise causes transitions in the output of the detector. When the average rate of these transitions matches the frequency of a signal of interest a nonlinear locking can occur which amplifies the signal. This mechanism has been shown to work in electronic and biological systems, even when a noise free signal is too weak to be detected directly.

PHASE I: Stochastic resonance will be demonstrated for weak signals buried in noise in a system which may detect acoustic, magnetic, electromagnetic, or another signal of interest. The effect of adding different types of noise, and adjusting the potential in the detector will be explored to find the optimum operating regime.

PHASE II: An operational stochastic resonance system will be developed and tested. Various methods of coupling stochastic resonators will be explored to increase the detector sensitivity.

PHASE III: Compact coupled stochastic resonators, perhaps in the form of an integrated circuit, will be designed, tested, and used as detectors underwater, on the sea, and in the air.

COMMERCIAL POTENTIAL: Stochastic resonance acoustics detectors can be used to detect earthquake precursor tremors. New types of hearing aids can be devised based on the principal of stochastic resonance.

N94-140 TITLE: High-Frequency Microwave Processing of Ceramics

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Materials and Structures

OBJECTIVE: Develop microwave-based techniques for processing of ceramics and nanopowders.

DESCRIPTION: In conventional sintering of ceramics heat is transferred into the bulk of the workpiece by conduction. This process is relatively slow and often produces internal stresses in the material due to nonuniform heating. In microwave heating, energy id deposited as the molecules vibrate in response to the electric field. Since the energy is absorbed near the grain surfaces throughout the workpiece, microwave heating of ceramics has several advantages over heating in a conventional oven. These advantages include rapid and uniform heating leading to short processing times, improved material properties and higher throughput.

PHASE I: Develop the basics of a high frequency microwave processing procedure for application to ceramics and novel materials such as nanopowders. Processes of interest include sintering, densification, coating, and jointing. Devise means of avoiding or controlling thermal runaway. Explore means to scale the microwave processing method to practical commercial levels.

PHASE II: Develop, test, and operationally demonstrate microwave processing of ceramics and nanopowders by implementing the methods formulated under the Phase I effort. Characterize the radiation source and the physical properties of the ceramic after microwave processing. Demonstrate superior properties of finished product such as higher densification or improved fracture toughness. Facilities at NRL may be made available for the Phase II portion of the program. Develop methods and techniques to commercialize the process.

PHASE III: Construct a practical, high volume, high frequency microwave ceramic processing facility.

COMMERCIAL POTENTIAL: The potential benefits of this technology will impact the capabilities of the multi-billion dollar U.S. ceramics industry. High frequency microwave facilities for processing of ceramics can be used to manufacture industrial products ranging from turbine rotors to military armor to electronics substrates.

N94-141 TITLE: Turnkey System for FMRI Studies of Human Cognition

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Cognitative and Neural Sciences

OBJECTIVE: To enable large numbers of cognitive researchers to exploit the potential of brain imaging technology to improve understanding of human information processing capacities, by reducing the technological difficulty of engaging in this research.

DESCRIPTION: Functional magnetic resonance imagery is a newly developed technique which uses the conventional MRI machines widely installed for clinical medical applications to provide pictures of brain activity while mental activities are being carried out. Because of the wide installed equipment base and non-invasive character of the technique, it has great potential. However, numerous technical details must be addressed in successfully carrying out such research, such as special adjustments of the MRI machine, stimulus displays in the presence of high magnetic fields, and coordination of image data analysis with conditions of stimulus display. A turnkey system is needed, which would incorporate facilities for efficient programming of a wide range of likely perceptual and cognitive experiments.

PHASE I: Design the turnkey FMRI system in detail, including the range of experiments to be provided for.

PHASE II: Develop a functioning prototype of the system, user instruction and documentation. Perform user testing.

PHASE III: Make the system commercially available.

COMMERCIAL POTENTIAL: Because of the exciting potential of this research and the large number of available MRI machines, this system would have a research market of respectable size. Potential applications in clinical neurosurgery, precisely locating functionally vital brain areas would provide a larger market.

N94-142 TITLE: Active Sonar Target Imaging and Classification System

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Cognitative and Neural Sciences

OBJECTIVE: Design and implement an analog VLSI system to accurately and robustly classify underwater objects in acoustic clutter and reverberation based on computational principles derived from active biosonar processing systems such as bat and dolphin.

DESCRIPTION: Active sonar-based target classification will play an important role in the Navy's future littoral warfare mission for the detection and classification of mines and other operationally relevant objects. Current active sonar systems are inadequate for anticipated shallow-water mission scenarios because they require many emissions per potential target, yield high false alarm rates, suffer high cluster interference, and have too limited a dynamic range. New models of active biosonar signal analysis, including bat-like target range profiling and the dolphin-like image construction have been demonstrated to eliminate or significantly reduce these problems. Biosonar-based signal processing systems can classify target reflections with one or a very small number of emissions, effectively identify and cancel ghosts produced by multipath scattering, and exploit narrow beam widths to reduce clutter interference and enhance dynamic range. Further work is needed to integrate these capabilities within analog VLSI technology to achieve the target imaging and classification capability required for Navy application.

PHASE I: Design a software simulation to demonstrate the feasibility of an integrated biosonar-based imaging system to achieve the advantages described above. Establish the feasibility of an analog VLSI implementation of the system.

PHASE II: Design, implement, test and evaluate a prototype system in analog VLSI based on principles and techniques incorporated into the software simulation developed during Phase I.

PHASE III: Refine and produce the prototypes developed in Phase II and make them available for commercial exploitation.

COMMERCIAL POTENTIAL: Efficient reliable VLSI technologies for underwater object imaging and classification will find application in undersea exploration, robotic guidance, radar imaging technologies for air traffic control, medical imaging and undersea resource commercialization.

N94-143 TITLE: Prognostic Techniques for Mechanical Failure Prediction

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Cognitative and Neural Sciences/Materials

OBJECTIVE: Develop prognostic techniques for predicting time to failure of machine components which integrate advanced signal processing with models of fault propagation in machine components such as bearings and gears.

DESCRIPTION: In order to implement condition-based maintenance on Navy sea and air fleets the technology for real-time diagnostics and prognostics of mission critical machinery needs to be developed. Recent advances in pattern recognition, such as neural networks operating on spectral features, have been applied to fault detection/isolation of vibration signatures of machinery with faulted components. In order to enable condition-based maintenance, such techniques need to be integrated with knowledge of the failure process to predict failure of the component and machine. We seek prognostic capability which would integrate pattern recognition of signatures of incipient or developing faults (based on sensors for vibration, acoustic, temperature, pressure, chemical composition and/or active sensors) together with models of fault propagation in machine components such as bearings, shafts, and gears.

PHASE I: Develop a hybrid architecture which combines advanced pattern recognition of fault signatures with models of fault propagation.

PHASE II: Demonstrate the capability of this system to accurately predict time to failure of machinery components, using real data.

PHASE III: Develop a design for compact hardware implementation together with sensors suitable for Navy machinery.

COMMERCIAL POTENTIAL: Potential commercial applications for mechanical failure prognostics are strong and include mechanical systems in helicopters, turbine engines, electric power generating facilities, saw mills, refrigeration equipment and manufacturing equipment.

N94-144 TITLE: Non-fouling Materials for Submerged Optical Sensors

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Materials

OBJECTIVE: Develop non-fouling, optically clear (visible and/or UV spectral ranges) materials that are suitable for submerged optical sensor windows with applications for long-term (months to years), unmaintained seawater deployment.

DESCRIPTION: The Navy currently exploits a wide-range of submerged optical sensors and the need to expand the use of such sensors and newly developed ones, particularly in the littoral zone, requires that new materials be developed that provide non-fouling features and allow for light transmission in either or both the ultraviolet and visible spectral ranges. These materials must maintain transmission properties and be fouling-free for deployment periods of months to years without maintenance.

PHASE I: Develop materials that possess appropriate transmission features for use as windows on submerged optical sensors in the visible and/or ultraviolet spectral ranges that do not foul under long-term field deployment.

PHASE II: Test and evaluate the long-term non-fouling capacity of materials for optical windows and define the resistance to crazing and decoloration over time of materials developed in the Phase I SBIR. The materials should be moldable and should have field life-time in excess of 1 year.

PHASE III: Produce materials suitable for a range of optical sensor applications making such materials available to the optical sensor industry with the specifications established in the Phase II effort.

COMMERCIAL POTENTIAL: New technology can be exploited in DOD, other federal and civilian sectors where optical monitoring is required in aquatic environments.

N94-145 TITLE: Inexpensive Phase Fluorometer for Lifetime-based Fiber Optic Biosensing

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Electronics

OBJECTIVE: Produce an inexpensive phase fluorometer suitable for lifetime-based sensing of chemical analytes through optical fiber.

DESCRIPTION: The Navy and DoD have an ongoing requirement for continuous monitoring of chemical analytes such as pollutants, wastewater contaminants,and process byproducts. One promising and cost-effective means for meeting these requirements is a fiber optic biosensor based on fluorescence lifetime changes of a suitable indicator phase. The heart of these sensors is a time-commercially available, they are very expensive and have more capabilities than are required for a particular sensing scenario. A phase fluorometer designed for a single sensing task might be much cheaper than a research-grade multifrequency instrument, while exhibiting all the performance necessary.

PHASE I: Design and construct a laboratory breadboard phase fluorometer with nanosecond resolution, suited to a particular sensing task to be agreed upon with the sponsor. Acceptable designs will be small, rugged, lightweight, require modest power, and not be liquid cooled. Use of all solid state components is encouraged.

PHASE II: Develop, test, and field demonstrate a phase fluorometer for fiber optic biosensing based on the Phase I breadboard and sensing task. The Phase II device should meet the Phase I criteria, and additionally be transportable easy to calibrate, and manufacturable in quantity. Production drawings should be completed.

PHASE III: Produce a fiber optic phase fluorometer which meets Navy and DoD requirements. Civilian applications will require little or no modification.

COMMERCIAL POTENTIAL: DoD/DoE environmental cleanup estimates exceed $400 billion, of which sampling and analysis may account for up to 30%. Other dual-use potential for advanced biosensors includes process control, explosive/drug detection, diagnosis, therapeutic monitoring, water purity assessment, agricultural testing, food and beverage production.

N94-146 TITLE: Bioemulsifiers and Enzymes for *in situ* Sludge Removal from Oil/Water Separators

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Environmental Quality and Civil Engineering

OBJECTIVE: Develop new, biologically based, materials and processes for sludge removal from shipboard oil/water separators

DESCRIPTION: The Navy must operate ships in compliance with federal and international laws governing oily wastewater discharge. The International Maritime Organization (IMO) is expected to lower the acceptable oil discharge limit from 15 ppm to 5 ppm by the year 2000. Oily wastewater discharge is controlled primarily through the use of oil/water separators. The performance of oil/water separators is impaired by build-up of oily sludge. Sludge removal now requires dismantling of separators, a laborious, expensive, and dangerous (because of release of H_2S generated by anaerobic conditions within the tank and accumulation of heavy metal in the oily sludge) operation. Biotechnologies for *in situ* cleaning of oil/water separators would provide economical and safe procedures that would be in compliance with environmental regulations.

PHASE I: Screen, identify, and characterize biosurfactants and/or enzymes that are effective sludge removal agents.

PHASE II: Develop, test, and demonstrate processes utilizing biosurfactants and/or enzymes that can be used *in situ* for sludge removal in oil/water separators that operate at no less than 10 gallon per minute.

PHASE III: Produce materials on a commercial scale for use in oil/water separators.

COMMERCIAL POTENTIAL: The world-wide business opportunities for environmental biotechnologies are tremendous. It is anticipated that all commercial vessels will be required to comply with IMO discharge standards. There is growing interest in the use of bioemulsifiers and biosurfactants to enhance the bioavailability of contaminants.

N94-147 Title: Tactical Exploitation of National Capabilities through Science and Technological Advances

CATEGORY: Basic Research/Exploratory Development/Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Primarily Command, Control, Communications/All

OBJECTIVE: To systematically explore the tactical use of National Systems and conduct cross-program cooperative studies between National, tactical, and commercial programs. To assess, coordinate, and transition new capabilities resulting from the scientific and technological exploitation of these systems toward fleet utilization and increased Naval and joint warfare capabilities.

DESCRIPTION: This SBIR topic is in direct response to the Department of Defense Appropriations Act of 1977 and Congressional direction for the revitalization of service Tactical Exploitation of National Capabilities (TENCAP) programs following the unprecedented use of National Systems during Operations Desert Shield and Desert Storm. Through a Memorandum of Agreement with Chief of Naval Operations (N6), the Office of Naval Research has established a Science and Technology TENCAP office that will develop high-risk, high-payoff advanced technological demonstrations, with supporting scientific and exploratory developmental programs, aimed at exploiting and optimizing National Systems' capabilities for increased Naval and joint warfighting capabilities.

PHASE I: Develop system concepts of operation for the further exploitation of National Systems for increased Naval and joint warfighting capabilities. These system concepts should consider cooperative interactions between National Systems, tactical, and commercial programs. Based on these concepts of operation, propose simulations and laboratory/experimental demonstrations that verify increased warfighting potential.

PHASE II: Demonstrate system concepts in simulations and/or laboratory/experimental demonstrations to verify increased warfighting potential. Prepare detailed documentation on experimental results. Propose follow-on operational demonstrations in Joint Chiefs of Staff (JCS) Fleet Exercises to test concepts of operations in realistic operational scenarios.

PHASE III: Demonstrate system concepts in JCS Fleet Exercise to verify operational utility of proposed National/tactical/commercial system exploitation. Prepare detailed documentation of system operational concept for use in system tasking and CINC utilization.

COMMERCIAL POTENTIAL: Algorithm development and system concepts have application in search and rescue, natural damage and environmental impact assessment, surveying, commercial shipping, and passive identification.

N94-148 TITLE: Interoperability of Commercial Small Low Earth Orbit (LEO) Satellite System with the Navy Fleet Satellite (FLTSAT) Terminal

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Command, Control, Communications

OBJECTIVE: Demonstrate interoperability of commercial LEO system such as ORBCOMM with the Navy's FLTSAT terminals.

DESCRIPTION: Commercial small LEO satellite services such as ORBCOMM will become available in 1994. This system is suitable to transmit small messages (120 characters) at low cost ($0.01/byte). It is cost effective to off-load non-critical small messages from the FLTSAT system to commercial system sparing more capacity for critical usage. An RF subsystem should be developed and integrated into the FLTSAT terminal so that it can transmit short messages at 148 Mhz up link to the ORBCOMM satellite. This system can also receive 137 Mhz down link message according to the public X400 email standard. The software of the Navy's FLTSAT terminal should be modified to handle the ORBCOMM Dynamic Channel Assignment Algorithm System (DCAAS) protocol. The Total system should work in the Navy's Copernicus communication architecture.

PHASE I: Develop the basics and design of the RF subsystem. It probably should be an VME bus card (6U) in the open architecture of the FLTSAT terminal. The modification of the software in the terminal should be simulated to handle the ORBCOMM DCAAS protocol.

PHASE II: Develop, test, and operationally demonstrate the operation of the FLTSAT terminal by sending and receiving short messages to the ORBCOMM satellite system. This subsystem is implemented according to the design in PHASE I. Message delay should have an average value of less than 15 minutes. If the average delay can not be guaranteed, priority level message transfer in ORBCOMM system should be considered.

PHASE III: Produce an RF subsystem and a software system that can work in a FLTSAT terminal as developed in the PHASE II effort.

COMMERCIAL POTENTIAL: New methodology can be used in commercial satellite terminals that requires access to small LEO system.

N94-149 TITLE: UHF 25 Khz Voice Channel Expander

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Command, Control, Communications

OBJECTIVE: Use 4.8 kbps CELP vocoder and associated forward error coding (FEC) to concentrate two secure voice channels into one 25 Khz UHF satellite channel.

DESCRIPTION: Shortage of UHF satellite channel occurs at the operational level. This project is able to expand available voice channels. Currently many commercial efforts concentrate on narrow band digital radio. NSA also has an effort to develop STUIII D device compatible to digital modulation. It is cost effective to expand the 25 Khz FLTSAT channel to accommodate multiple secure voice channels. The secure voice channel expander most likely includes a new design of the modulation and encoding methods under the constraints of power, bandwidth and interference of the FLTSAT channels.

PHASE I: Develop the basics of the vocoder, FEC, frames, modulation and encoding method to concentrate two secure voice channels. The effort also includes design of the new STUIII D end to end encryption device for the voice channel.

PHASE II: Develop, test and operationally demonstrate a 25 Khz voice channel expander that implements the encoding methods formulated under the Phase I effort. The expander should be a modular and open architecture design integratable into the Navy's Copernicus TADIXS communication architecture.

PHASE III: Produce an UHF SATCOM voice expander that implements the design demonstrated in Phase II.

COMMERCIAL POTENTIAL: New methodology may be used to expand the voice capacity in existing commercial links.

N94-150 TITLE: Optoelectronic Signal/Image Processing for C3I Applications

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Command, Control, Communications

OBJECTIVE: Develop optoelectronic technology and/or signal processing modules that support Navy C3I systems based on multi-function phased array antennae shared by radar, ESM, ECM, and communications subsystems.

DESCRIPTION: Future Navy C3I systems will reduce the number of separate shipboard and airborne antennae by sharing adaptive phased array antennae, multifunction receiver modules, and common signal processing resources. Enabling technologies for this concept include wideband phase shifters, methods for adaptive multiple-beam steering, optical techniques for addressing and interconnecting large numbers of wideband T/R modules, and robust methods of Automatic Target Recognition (ATR). Proposals which exploit the inherent parallelism of optical systems or the speed/bandwidth of photonic technology, including nonlinear optical phenomena, will be considered.

PHASE I: Investigation of proposed concept; identification of innovation and discussion of technical issues. If necessary, laboratory demonstration proving feasibility of concept or resolution of controversial issue.

PHASE II: Design of prototype; demonstration of concept with prototype system; discussion of all relevant performance scaling issues and production or manufacturing issues.

PHASE III: Commercialization of prototype developed in phase II; market surveys and analyses; business plans commercializing product, either in-house or in conjunction with an appropriate industry.

COMMERCIAL POTENTIAL: The wideband technology components and systems developed for this program have numerous commercial opportunities within the high-speed telecommunications, satellite communications, and digital multimedia distribution markets. In addition, relevant software products designed for efficient DoD resource allocation and data fusion are equally applicable to industrial concerns.

N94-151 TITLE: Modeling of Composite Explosive Detonations

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Conventional Weapons

OBJECTIVE: Development of enhanced composite metallized explosives for underwater applications with maximum total energy and energy release rate profile tailored to optimize application specific performance.

DESCRIPTION: For underwater applications, it is essential to design high performance composite metallized explosive formulations whose characteristics can be tailored with a user prescribed profile for energy release and other detonation processes. A thorough understanding of the processes responsible for the conversion of chemical energy in the explosive into kinetic energy released into the water column as shock and expanding detonation product gases during and after the detonation, is required before this can be achieved. There is an excellent understanding of the thermodynamics, and there are good equilibrium codes which are adequate to describe the detonation of "ideal" explosives. However, there is no adequate description of the kinetic and microscopic transport processes which control the kinetic energy profile and thus the performance of "non-ideal" (composite) explosives.

PHASE I: Identify the physical and chemical processes which occur during the decomposition of oxidizer molecules and subsequent reaction of these molecular fragments with metal fuel particles at temperatures and pressures characteristic of detonations.

PHASE II: Develop the methodologies necessary to describe the time dependent processes which control the rate of energy release in the detonation of composite metallized explosives.

PHASE III: Produce a computer code which incorporates the chemical kinetics and microscopic transport processes inherent to the detonation of metallized composite explosives which can be integrated with existing thermodynamic and fluid dynamic codes to accurately describe the detonation and energy release characteristics of metallized composite explosives.

COMMERCIAL POTENTIAL: Private sector applications include mining and tertiary oil recovery technology in which a combination of both shock and high impulse (integrated pressure with time) is essential to maximize oil fracturing and rubbleization processes.

N94-152 TITLE: Surf Zone Mine Neutralization/Clearance

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Conventional Weapons

OBJECTIVE: Identify and quantify the effectiveness of using smart munitions for clearance of anti-invasion mines and obstacles in the surf zone (0-10 feet water depths) preceding an amphibious assault. This includes, materials that can be released to immobilize, desensitize or otherwise render safe.

DESCRIPTION: Anti-invasion mines are placed in large quantities in beach areas to prevent an amphibious landing. These mines must be quickly cleared or neutralized using techniques which are cost-effective and deliverable form available platforms. Munitions using smart sensors may provide accurate payload placement and a cost-effective solution to this problem.

PHASE I: Develop concept using above suggestion or alternate method. Identify and describe concept in terms of size, weight, and explosives or other materials delivered. The mechanisms for target detection and reacquisition and all development/not development items will be identified and described. Quantified analysis will be made to estimate percent effectiveness for the proposed concept.

PHASE II: A prototype will be developed and demonstrated. Effectiveness to clear or neutralize mines and/or obstacles will be demonstrated. Simulation models of the prototype in varying scenarios will be developed to aid in concept demonstration.

PHASE III: Field test against inert targets.

COMMERCIAL POTENTIAL: Supporting sensor technology will be useful in location and marking of hazardous objects in the coastal environment. Ordnance disposal artificial reefs.

N94-153 TITLE: Stabilizing Materials for Beachhead Mine Immobilization

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Conventional Weapons

OBJECTIVE: Develop easily deployed stabilizing materials (e.g., a foam) that can be released in very shallow water and the surf zone region to immobilize or desensitize mines on or near the bottom to allow safe passage.

DESCRIPTION: The very shallow water and surf zone mine clearance operation involves divers or small UUV's that must locate, identify, and mark bottom, near bottom, and buried mines. These mines would generally be triggered by movement of a tilt rod, or by exceeding the pressure, magnetic, or acoustic signature needed to exceed the influence triggering threshold. Currently each mine so located must be exploded of immobilized by placing an explosive charge on the mine. New and unique ways for dealing with high density minefields of this type are needed. Conceptually, one can imagine covering the mines with some type of rapidly hardening material that would inhibit the operation of tilt rod mines or shield the influence sensors of the mine from the signature of the passing vessel. Such materials would need to be effective in the presence of the diluting effects of the large volume of sea water.

PHASE I: Develop the concept via a paper study and system conceptual design.

PHASE II: Fabricate a prototype system and demonstrate the concept in a suitable test environment.

PHASE III: Transition the technology to the acquisition sponsor upon successful completion of Phase II.

COMMERCIAL POTENTIAL: Explosive ordnance disposal, artificial reefs.

N94-154 TITLE: Unmanned Undersea Vehicle Sensors for Mine Survey and Wave Conditions

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop systems for UUVs to survey for mines in shallow and very shallow water, sense oceanic parameters of interest and report results of survey and sensing in real or near-real time to tactical decision makers.

DESCRIPTION: Unmanned Undersea Vehicles will play an important role in littoral warfare due to their ability to covertly survey for moored, bottom and buried mines and simultaneously measure ocean characteristics of interest to the tactical commander. Systems are needed that combine sensors to improve range and resolution of mine location and identification processes, to sense oceanographic conditions, particularly wave and surf, process data on board and report results promptly and accurately. It is desirable to combine these missions using an appropriately sized package to minimize power and space requirements aboard the chosen unmanned platform.

PHASE I: Perform conceptual system design that maximizes mine hunting performance. Topic focus may be on system components rather than the entire system. Identify requirements to be met in area of measurement of wave and surf parameters, data processing and storage, and appropriate data relay.

PHASE II: Develop a prototype system that can be integrated and field tested with a suitable UUV. Perform field tests and evaluate results.

PHASE III: Finalize system design and develop final designs for production:

COMMERCIAL POTENTIAL: Underwater well head, piping survey, underwater salvage, sea floor surveys etc.

N94-155 TITLE: Zinc-Selinide (ZnSe) Substrates for Blue Lasers

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Electron Devices

OBJECTIVE: Develop ZnSe substrates for the epitaxial growth of ZnSe based alloys for light emitting diodes and, particularly, lasers in the blue-green region of the optical spectrum to meet Navy and commercial requirements including communications and displays.

DESCRIPTION: A major problem in growing epitaxial materials for light emitting devices in the blue-green spectral region is lack of suitable substrates. This is particularly true for the case of blue lasers since direct bandgap materials are required.[1,2] Zinc selenide shows promise for such development and is advantageous for lasers since the epitaxial ZnSe based alloys are direct bandgap materials. It is particularly desirable to develop (100) ZnSe substrates for subsequent molecular-beam-epitaxial (MBE) active-materials growth.

PHASE I: Develop optimized rates of ZnSe substrate material growth and optimize pretreatment steps. In particular, substantially slower initial growth rates ($\leq$ 3 mm/h) and somewhat slower end growth rates than those currently used are desired. This Lightweight Surveillance Radar phase should address other areas such as growth conditions, crucible design, and doping parameters, but growth rates and pretreatment steps should be emphasized.

PHASE II: Develop highly doped n-type materials ($\approx 1 \times 10^{18}$ cm^{-3} doping densities), developing optimized temperature and vibrational growth conditions, design of crucibles and gradient applications, and exploring the potential of using different growth gas ambients. While these tasks are expected to involve substantially more effort than the phase I efforts, it is expected that growth rates and pretreatment steps will continue to receive attention and be optimized as the tasks emphasized in Phase II tasks are carried out.

PHASE III: Produce commercial blue-green ZnSe based semiconductor lasers.

COMMERCIAL POTENTIAL: Blue-green lasers and LEDs for communications and displays.

N94-156 TITLE: Molecular Electronics Device Support

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Electron Devices

OBJECTIVE: To identify techniques to measure electronic properties of molecular scale devices.

DESCRIPTION: Molecular electronics consists of devices that are constructed from individual molecular components upward rather than from bulk systems downward. These devices offer great promise for reducing weight and power consumptions as well as increased operational speed. Molecular wires, switches, sensors and a host of other devices have been constructed; however, no capability exists to measure their electronic properties. While the construction of single devices is a significant achievement, the production of complex devices with appreciable yields is the real goal. This will only be achieved when we are able to characterize the component devices adequately.

PHASE I: Develop experimental techniques to characterize any of the electronic properties of molecular scale devices and identify the most promising.

PHASE II: Develop prototype of the system proposed in Phase I studies and evaluate the system on several devices.

PHASE III: Refine prototype for transition to a naval advanced development program, the Navy microelectronics program and/or a Cooperative Research and Development Agreement with naval R&D laboratory.

COMMERCIAL POTENTIAL: The commercial potential is very large as nanoelectronics replace the microelectronics of today.

N94-157 TITLE: Bistatic Passive Ranging

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Electronic Warfare

OBJECTIVE: Employ bistatic range/geometry correction techniques using ship's Electronic Warfare (EW) systems to solve for instantaneous range to selected emitters. Provide an increased Ships Self Defense EW capability to existing SLQ-32 and SLQ-32 upgrades/Advanced Integrated EW System (AIEWS) equipped ships by providing a technique to generate range data to supplement the EW system's threat emitter identification, azimuth and elevation information.

DESCRIPTION: Present EW systems provide threat emitter location in azimuth and elevation but cannot provide instantaneous threat range. The subject technique will exploit the threat emitter's signal and target returns to provide range information automatically, thereby enabling more efficient use of replenish-able and non-replenishable EW techniques, tactics and devices. Inclusion of a capability to passively track radiating threat seekers would furthermore allow early determination of the targeted platform, and would facilitate closed-loop Electronic Protection (EP) effectiveness evaluation. Performer must have appropriate security clearance.

PHASE I: Define operational parameter of threats, methodology for interfacing passive range system to EW system, algorithm concepts to generate passive range data, algorithms to extract and correlate data, and EW system modifications required, as well as hardware, software, system concept. Prepare proof of concept demonstration plan and detailed phase II cost and schedule.

Phase II: Develop passive ranging hardware brassboard and interface designs with ship's EW System. Make ship's EW system modifications. Prepare detailed test plan. Conduct limited proof of concept tests. Prepare and submit test results and test report.

Phase III: Produce and successfully demonstrate a prototype system
compatible with existing shipboard EW systems at sea. Prepare and submit test results, test report and recommendations. Prepare system functional and performance specifications.

COMMERCIAL POTENTIAL: As with the majority of EW technologies, this EW technique affords exceptionally limited potential for commercial applications.

N94-158 TITLE: Large-Area Acoustics Control Panels

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Structures and Materials

OBJECTIVE: Devise methods to make materials, in the form of large area panels incorporating sensors and actuators as integral constituents, for adaptive control of structural, fluid borne, or air borne acoustics.

DESCRIPTION: Currently, the control of structural acoustics is achieved by attaching external localized sensors and actuators to the structure. In contrast, this materials research topic targets the synthesis of large area panels containing integral sensors and actuators that can be directly imbedded within the structure to achieve the desired acoustic control, for example, reducing the structure's own motion, acoustic radiation, or acoustic reflectivity. These research efforts will focus on cost-effective methods to make materials incorporating acoustic sensors and actuators for structural acoustics control, and not extend to the electronics or control algorithms involved in their use.

PHASE I: Devise materials fabrication methods to produce large area panels incorporating, as integral material constituents, acoustic sensors and actuators that could be used to control the acoustic characteristics of structure in which they are imbedded.

PHASE II: Fabricate large area acoustic control panels, imbed them within a large (linear dimensions exceeding one meter) prototype structure, and demonstrate their potential to control the motion, acoustic radiation, or acoustic reflections from the prototype structure.

PHASE III: Design and manufacture large area panels containing integral sensors and actuators to control structural acoustics in military ship and aircraft applications as well as civilian aircraft, automotive, and building applications.

COMMERCIAL POTENTIAL: Broad civilian applications in environmental quieting in buildings, aircraft and automobiles are supplemented by critical defense applications for controlling structural acoustics in ships, helicopters, and airplanes.

N94-159 TITLE: Piezoelectric Composite Transducers

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Structures and Materials

OBJECTIVE: Devise acoustic and vibration control applications for piezo composite materials. Concentrated R&D efforts have made feasible manufacture of composite piezoelectric elements for sensing and actuation. This topic targets the development of applications for these materials. Potential Naval applications include acoustic sensing and vibration control. Similar applications are visible in aircraft, automotive, and environmental noise abatement. Innovative proposals to expand the application domain to entire new fields are encouraged. Applications can use single layer or stacked applications of this technology. The focus here lies on imaginative uses rather than materials synthesis.

DESCRIPTION: Recent developments in the manufacture and design of composite transducers has resulted in products with attractive properties. Piezoelectric ceramic rods oriented vertically in a horizontal polymer matrix form the so-called 1-3 composite transducers. Panels measuring 46 cm on a side and 1 cm thick have been produced based on piezoelectric ceramic rods 1 mm diameter * 6 mm long. This composite contains 15 volume % ceramic and the polymer filling the spaces between rods is cellular, providing a low-density transduction material. Thin, rigid face plates are bonded to the surfaces to permit uniform surface response or planar actuation. This materials research topic targets development of applications for this technology, not necessarily in the dimensions and configuration described above.

PHASE I: Devise applications for 1-3 and/or 0-3 composite transducer technology having military or commercial applicability. Devise concepts to exploit current manufacturing processes.

PHASE II: Fabricate and/or procure materials and configure demonstration device or devices which can be tested against the proposed performance or function.

PHASE III: Demonstrate application by total prototype fabrication and testing could include, but are not limited to, critical defense applications for controlling structures or devices in ships, helicopters, and airplanes.

COMMERCIAL POTENTIAL: Private sector applications could include, but are not limited to, applications in acoustic instrument isolation, environmental quieting in buildings, aircraft and automobiles.

N94-160 TITLE: Overcoming Environmental Limitations on Active Sonar Detection Performance

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Software/Sensors

OBJECTIVE: Demonstrate improved active sonar detection performance by understanding and overcoming the oceanic environment.

DESCRIPTION: The Navy increasingly relies on active sonar for detection, but performance is degraded by time dependent multipath propagation. This vertically integrated demonstration program seeks to improve performance and overcome these degrading effects by defining the environmental information required, acquiring it, and demonstrating improved detection performance by its use. Conventional, side scanning sonars used widely for both military and commercial bottom search applications suffer from reduced resolution at long range. Therefore, search rates are limited at high resolution without increasing the length of the acoustic array to an unmanageable size. Synthetic aperture techniques offer, in principle, the possibility of obtaining high resolution at much longer ranges with the same size physical array; however, significant difficulties must be overcome, including very stringent requirements on motion compensation, compensation for fluctuations in the medium, and calibration and stability of the acoustic transducers and electronics. In addition, efficient synthetic aperture processing and display algorithms must be developed to enable real-time operation.

PHASE I: Define the environmental information required and the means to obtain it. Estimate the improvements in system performance that will be achieved when the environmental information has been acquired. Justify the predicted performance improvements by modeling or with actual data.

PHASE II: Verify the performance improvement predictions by obtaining and employing the necessary environmental information and employing it in a prototype system.

PHASE III: Develop, test and demonstrate sonar system detection performance improvement based on overcoming the effects of time dependent multipath propagation in the ocean.

COMMERCIAL POTENTIAL: It is desired that the environmentally based improvements in performance should be demonstrably capable of providing similar benefits in commercial active sonar systems.

N94-161 TITLE: Artificial Intelligence, Data Fusion and Mine Recognition System

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Software/Sensors

OBJECTIVE: Develop a high resolution underwater imaging systems using artificial intelligence to combine or fuse multiple sensor inputs and machine learning algorithms to detect, classify and identify a variety of mines.

DESCRIPTION: At present underwater mines are detected by sonar, and identified by television from a two-dimensional gray shaded image. A system combining sonar, electro-optical and laser derived imagery with artificial intelligence offers a means of increasing the accuracy of the detection, classification and identification process.

PHASE I: Identify the sensors and assess the ability of the technology to perform the needed mission. Design algorithms necessary to perform data fusion and target classification/identification from the fused images.

PHASE II: Construct a prototype system and demonstrate its capability in a laboratory test.

PHASE III: Construct document and demonstrate a field-robust system in a Navy-selected shallow water area.

COMMERCIAL POTENTIAL: Supports use of sonar imagery for other applications, including shallow water sea salvage, and location and mapping of underwater objects such as shipwrecks, pipelines, etc.

N94-162 TITLE: Ship Construction Process Modeling

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Surface/Undersurface Vehicles

OBJECTIVE: Create a higher quality and better integrated design package by utilizing commercially available software to develop innovative modeling components that facilitate the communication of shipbuilding production concepts without building prototypes. The modeling components are independent of ship type, therefore this generic design package has equal applicability to commercial shipbuilding as to U.S. Naval shipbuilding.

DESCRIPTION: To build more affordable ships, the need to design ships with production processes in mind is paramount. Modern shipyards build ships by dividing the ship into sub-components or blocks and pre-outfit those blocks to the fullest extent possible before actual ship installation. This is a three dimensional process that is most easily explained through visualization. Currently the Navy uses two dimensional system diagrams and plan views in an attempt to visualize this combination linear and non-linear process. In order for the Navy to generate a quality design product that facilitates modern construction techniques a visualization analysis tool is needed. This can best be accomplished through the concept of virtual reality. Preliminary demonstration projects funded by the Advanced Research Programs Agency (ARPA) show great promise through the utilization of commercial hardware and software.

PHASE I: Model the hull block construction of a recent U.S. Naval ship showing the sequencing. Satisfactory completion and demonstration of the modeling allows transition to Phase II. Deliverables are reports documenting the model development and a video tape showing, in real time, the process.

PHASE II: Model representative detailed subassemblies and completely outfitted modules containing habitability spaces. Incorporate the above detailed models into the model from Phase I. Utilize commercially available human factors programs to analyze habitability spaces and determine benefits gained from such an approach both in terms of shipyard assembly and in terms of day to day living. Satisfactory completion and demonstration of the modeling allows the transition to Phase III. Deliverables are reports documenting the model development and approach analysis as well as a video tape showing, in real time, the process.

PHASE III: Develop a generic ship hull block construction sequencing procedure and modeling method that incorporates prefabricated and outfitted modules. Demonstrate technique by modeling a recent or proposed commercial ship. Deliverables are reports documenting the model development a video tape showing, in real time, the process, the software used, a training course on how the software modeling is accomplished, and a menu driven system for walking through the process. All software utilized and developed must be compatible with on going ARPA/DON efforts in this area.

COMMERCIAL POTENTIAL: The software tools developed would be ship generic and would apply to developing designs for commercial ships (both new and overhaul). Commercial shipyards could also use this software to help them better fabricate new acquisition U.S.Naval ships.

N94-163 TITLE: Regenerated Diesel Engine for Low Emissions and High Power Density

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Surface/Undersurface Vehicles

OBJECTIVE: Develop a concept to reduce emissions, improve fuel efficiency and increase power density of a diesel engine by employing regeneration.

DESCRIPTION: Diesel engines presently available in the U. S. Navy do not meet proposed emissions regulations and have a low power density when compared to gas turbines and gasoline engines. This program will identify candidate materials and concepts that will allow a diesel engine to meet the environmental regulations for exhaust emissions as well as the Navy requirement for high power density and fuel efficiency.

PHASE I: Present a concept to employ regeneration in a diesel engines. Candidate materials for the regenerator will have undergone evaluation of material properties in an engine environment. The deliverables will include a data base for all the materials evaluated.

PHASE II: The regenerator will be tested in a single cylinder diesel engine to determine its effectiveness in terms of emissions, power density and fuel efficiency.

PHASE III: The concept will be tested in a multi-cylinder diesel engine which is representative of a Navy diesel engine.

COMMERCIAL POTENTIAL: Interest from major engine companies is expected after completion of a successful Phase II. Significant potential for applications in commercial U. S. shipbuilding regulated by The U. S. Coast Guard and MARAD. Other applications in commercial aircraft, pleasure boats, offshore drilling platforms and land based systems.

N94-164 TITLE: Low-Cost Stealth Surface Craft for Minehunting Applications

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Surface/Undersurface Vehicles

OBJECTIVE: Develop a low-cost, remote controlled, stealthy surface and submerged vehicle as a minehunting platform for near-vertical, acoustic detection of bottom and buried mines in shallow and very shallow water, and in the surf zone.

DESCRIPTION: Most minehunting sonar concepts focus on detection outside the lethal range of the mine being detected. This results in shallow incident angles for the acoustic energy from the sonar beam and greater difficulty for sediment penetration and detection of buried mines. At near normal incidence, better bottom penetration and detection will occur. The difficulty with operating at normal incidence is that the proximity of the sonar platform to the mine is increased and the liability that the platform may be destroyed is increased as well. If the acoustic and magnetic signatures of the platform are of such a low level that they do not trigger the mine detonating mechanism, or the system is of such low cost as to be expendable, then mine detection at normal incidence with greater assurance may be possible.

PHASE I: Develop the concept including studies predicting acoustic and magnetic signatures for a vehicle concept able to perform the minehunting mission.

PHASE II: Build a prototype to measure the actual signatures.

PHASE III: Transition technology to an Advanced Development Program.

COMMERCIAL POTENTIAL: Underwater wellhead/piping survey, underwater salvage, sea floor sediment surveys, etc.

N94-165 Title: Iconic, Graphic, Data Flow Programming for High-Performance Real-Time Workstations

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Software

OBJECTIVE: Develop and implement efficient [automated] software development tools for developing architecture-independent software for antisubmarine warfare processing systems. Develop high performance graphs (including parallelism) for signal processing including passive beamforming, data processing, and graphic data display.

DESCRIPTION: Develop for a coarse grained parallel multiple instructions/multiple data workstation a software tool that will permit the real-time processing of acoustic data using data flow graphs. Such a work station might consist of a SUN outfitted with a mercury quad board, transputer board(s) or other parallel processor options; to include: 1) A graphical programming language consistent with the Navy's Processing Graph Method (PGM) Specification providing for iconic description of parallel implementations of signal processing applications; 2) A mandatory intermediate textual representation of the graphical program consistent with Processing Graph Notation; 3) Ada or C++ programs, consistent with PGM Command Programs, for supervising graph execution parameter changing, starting and stopping graphs in an efficient manner, etc.; 4) A library of primitives supporting standard signal, image, data, and display routines which underlie the nodes of that data flow graphs; 5) Translation tools that translate graphs and command programs to executable code that allows the operator to change the topology of the processing graphs without restarting the processing session; 6) Run-time support to effect data flow execution of the application graphs to be based on some specific description of the workstation's architecture. Perhaps this could be accomplished with a formal set of architecture services that can be ported to various environments. The hardware architecture and instruction sets being data that is provided independently to the software tool that can be changed independent of the processing graphs. This layer should be beneath the user operating system calls such as POSIX or some other standard.

PHASE I: Develop a system which shall include front end specification tools so that a target machine is a selectable entity, requiring only the notation that describes a new architecture and not requiring applications to be rewritten.

PHASE II: Design, develop, and assemble an ASW processing workstation using off-the-shelf commercial components for Navy approved tactical algorithmic processing chains.

PHASE III: Specification of the software tool will be provided to prime contractors of SURTASS, Surveillance Direction System (SDS), and Advanced Distributed Systems (ADS) as an enhanced software programming capability for potential technology insertion and for significantly reduced software development and maintenance through plus reuse and minimum cost transportability.

COMMERCIAL POTENTIAL: Several corporations are now offering non-real-time. non-parallel architectures, non-distributed processing, and hardware unique capabilities of iconic data flow graphic programming. The cost of producing real-time systems and then moving from one hardware architecture to another is prohibitive, requiring the rewriting of most or all of any existing application software.

N94-166 TITLE: Protection of Naval Computers from Denial-of-Service Attacks

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Software

OBJECTIVE: To render Navy operational and development systems free from inadvertent intrusion and potential destruction or unauthorized use.

DESCRIPTION: The Navy is making increasing use of networks of commercial desktop computers with standard Unix operating system software. Some of these computers are updated with new software from remote locations. Ideas are solicited about how to protect these computers, their software, and their networking components, from deliberate or accidental attacks that would cause widespread denial of service. This solicitation is not for technology to prevent unauthorized disclosure of information, but centers on preventing a contaminated or hostile node from interfering with the proper operation of other computers to which it is connected. Detection and identification of attacking nodes would be useful, but limitation of spread of contamination and maintenance of normal operation by uncontaminated nodes are most important.

PHASE I: Compose a taxonomy of denial of service vulnerabilities covering system-level vulnerabilities by degree of vulnerability, operating system (e.g. Unix, MS-DOS, Windows/NT, Macintosh), network (e.g., Internet, AppleTalk, Novell), degree of compromise of hostile nodes (individual account, operator privileges, system administrator privileges, etc.), motive (e.g. curiosity, terrorism, information warfare), and any others deemed helpful. Identify and prioritize important tasks needed to remove/reduce current vulnerabilities. Create, in coordination with the PI, a plan for carrying out at least two from the list. Provide the results at a (government-sponsored) workshop and revise findings according to peer review.

PHASE II: Develop a proof-of-concept prototype or methodology demonstration to demonstrate the effectiveness of one or more approaches to reducing or removing denial of service vulnerabilities in a prototypical Navy environment. Identify and justify the environment to be used, carry out the plan, and evaluate the results. Document methodologies.

PHASE III: Apply approaches from Phase II for full scale systems. The goal in this phase is to demonstrate concepts and approaches developed in Phases I and II to a full-scale Navy systems. Successful results of this research will be transitioned to full-featured, reliable products or well-documented services that can be used to protect Navy systems.

COMMERCIAL POTENTIAL: Because the commercial world will depend on the same commercial technology to which the Navy is moving, approaches, tools, and solutions developed under this project should have direct and immediate application there, as well as in all facets of government systems.

MARINE CORPS SYSTEMS COMMAND

N94-167 TITLE: Long-Term Corrosion Prevention for Marine Corps Equipment

CATEGORY: Exploratory Development

SERVICES CRITICAL TECHNOLOGY AREA: Materials and Structures

OBJECTIVE: Develop low cost, low maintenance, corrosion control for Marine Corps equipment, especially tactical vehicles.

DESCRIPTION: Many corrosion problems experienced by the Marine Corps are caused by exposure to salt air/spray during exercises or on deployment. Vehicles are typically found throughout the world, used in every conceivable environment, embarked on Landing Craft Air Cushion (LCAC) and in the well deck of ships. A method is needed to protect the equipment from the environment and reduce or eliminate maintenance requirements. This effort is to design/develop a system that can be used to protect equipment from the environment. The Marine Corps requires a process that can be used in many situations to prevent corrosion and protect equipment. Technology needs to address the multiple needs encountered in a system level. For example, a system such as, the Assault Amphibian Vehicle, has unacceptable corrosion levels found on the engine, the transmission, the electric\communications systems, suspension systems and virtually all attached or collateral gear.

PHASE I: Identify one or more processes that provide low cost, low manpower, corrosion prevention for Marine Corps equipment. Conduct detailed study of Marine Corps assets at two Marine Corps locations.

PHASE II: Demonstrate low-cost, low-maintenance corrosion control process/system for Marine Corps equipment.

PHASE III: Integrate results in one or more major systems to evaluate effectiveness.

COMMERCIAL POTENTIAL: Improved processes for corrosion control would be especially useful in the dual use applications in regards to the automotive industry and heavy construction equipment manufacturers. The technology would also be useful for other applications where equipment needs to be protected from the environment during operation, and just as importantly, when in storage.

N94-168 TITLE: New Methods to Desalinate Seawater

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY: Environmental Quality

OBJECTIVE: To investigate advanced and innovative desalination methods that can produce potable water from seawater.

DESCRIPTION: Current military water desalination equipment uses a membrane separation technology called Reverse Osmosis (RO) in order to desalinate seawater by means of the Reverse Osmosis Water Purification Unit (ROWPU). Although relatively energy efficient compared to distillation technologies, RO still requires an appreciable amount of power, chemical resupply, and multi-stage filtration for pretreating the feed water. In addition, knowledgeable operators are required to constantly monitor and maintain the ROWPU and its chemical addition system. There are emerging technologies today that posses the potential to desalinate water with less operator interface and pretreatment requirements than RO technology now requires. These technologies should be evaluated for their military as well as industrial and municipal applications. The new technologies developed must be compared against current RO desalination processes.

PHASE I: Develop new desalination equipment. Provide a detailed description of the technology indicating the size, weight, and cost for a system capable of producing 1200 gallons per hour (GPH) of potable water from a seawater source.

PHASE II: Based on the results of Phase I construct a 1200 GPH prototype to prove and demonstrate the engineering design parameters for the new technology. All test data and relevant information regarding this prototype such as reliability, maintenance, and manpower requirements shall be provided. The prototype shall be provided for extensive testing at the seawater desalination test facility.

PHASE III: The new technologies developed could replace the aging ROWPU systems as the military updates its equipment needs and requirements.

COMMERCIAL POTENTIAL: There is a large amount of commercial potential for new desalination methods. The municipal water supply industry could greatly benefit from research in this area. The current drought conditions in many areas of the world and need for reliable and additional sources of fresh water to meet the needs of an increasing urban population make this a timely and important topic of research.

N94-169 TITLE: Point Recognition Terrain Marking Technology

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Materials/Software/Conventional Weapons

OBJECTIVE: Design and develop prototype/proof of concept demonstrators for an Advanced point recognition Terrain Marking capability to enhance daytime and nighttime target acquisition for close air support for mobile and static battlefield situations involving combined arms forces.

DESCRIPTION: Development of innovative terrain marking concepts should include artillery, mortar, rocket delivered devices, and hand held/man portable devices to provide enhanced target marking capabilities. These concepts should (1) maximize the target marking duration from 5 to 30 minutes, (2) provide an easily recognizable common point of reference on the battlefield to assist in the acquisition of targets by CAS aircraft and ease communications required to direct aircraft on a specific target, (3) define the battlefield for the pilots and commanders alike in the attack of targets and the reduction of fratricide during day and night operations, (4) optimize marker/terrain contrasts. Reductions in weight and size required for hand held/man portable devices. Potential desired for innovative materials, durability, and reuse.

PHASE I: Concept exploration resulting in the provision of a feasibility study which outlines currently available or new technologies, capabilities, or design approaches that could be utilized in an integration and/or fabrication of systems possessing the above described attributes. Phase I will also include the delivery of a technical proposal which outlines a specific design approach. The design approach will include: a development plan, the specification of manufacturing technologies to be used, and the specification of performance capabilities and trade-offs.

PHASE II: Implementation of Phase I design in the building of two proof of concept/technology demonstrators capable of being tested in a field or range environment. Data will be collected to verify performance capabilities and will be provided in a final system evaluation report. The final system evaluation report should include any recommendations addressing noted deficiencies to improve performance and/or to meet other requirements.

PHASE III: Produce a PRP that implements all of the improvements demonstrated in the Phase II SBIR effort.

COMMERCIAL POTENTIAL: New marker concepts can be used in search and rescue operations, life flights, and police operations.

N94-170 TITLE: Co-Site-Interference Mitigation Effort for Amphibious and Land Combat Vehicles

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Command, Control, Communications

OBJECTIVE: Explore innovative approaches to minimize the co-site-interference for combat radio communication systems in military land combat and amphibious combat vehicles.

DESCRIPTION: Current command and communication control systems are targeted to the co-site-interference generated by radio transmitters, thus degrading receiving (voice and data) performance. Co-site-interference results from collocated transmitters interfering with each other. The current command communications systems in the AAV7CA1 amphibious vehicle controls five transmitters (T) and four receivers (R) in the VHF area; one VHF/UHF R/T, and one HF R/T. In addition, one Position Location Reporting System (PLRS) installation is planned. New configuration will provide the AAVC7A1 with a new generation of VHF SINCGARS radios, maintaining the same HF and VHF/UHF configuration. However, if the new configuration is implemented, a total of 12 antennas will be required and installed on top of the AAVC7A1 for radio communications causing a catastrophic RF environment, thus degrading the capability for voice and data. Any proposed hardware must be based on current technology and must interface with three different types of radios plus PLRS and future requirements such as the Global Positioning System (GPS). Proposed hardware should meet the following requirements:

- Able to fit in the AAVC7A1
- Ruggedized equipment
- User friendly and fault tolerant
- Run from unregulated 18-32 Volt DC power with 500 Hz ripple
- Minimize antenna quantity
- Be able to survive land combat vehicle and amphibious vehicle environment
- Have MTBF greater than 10,000 hrs and
- Have MTTR less than 3 hrs

PHASE I: At the end of six months, the contractor should provide at least 3 optional approaches that are possible solutions to minimize the collocation problem. The proposals should be of sufficient detail to allow for government review and selection.

PHASE II: At the end of a two-year effort, it can be expected that one or two approaches will have been installed and demonstrated in an AAVC7A1.

PHASE III: If successful, it is anticipated that such an approach will have immediate benefits for AAV, other combat vehicle platforms, and other fixed platforms within the Marine Corps as well as other Government agencies.

COMMERCIAL POTENTIAL: The techniques explored here may have immediate use in commercial application for land and air vehicles.

N94-171 TITLE: High-Accuracy Azimuth Sensor

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Sensors

OBJECTIVE: The development of a compact, hand-held reliable, automatic, highly accurate azimuth sensor for individual use or integration into individual or crew-served weapons systems.

DESCRIPTION: The proposed effort should address the development of the technology needed to provide a compact sensor capable of measuring azimuth to an accuracy of 0.5 degrees or better. Unit must be compact, hand-held unit that maintains reliability, and operate successfully in adverse field environments for individual use or integration into individual or crew-served weapon systems. Such systems would include the Advanced Forward Observer/Forward Air Controller (FO/FAC) device and Advanced Sensor Air Defense Systems (ASAD) currently under development and testing. Additionally, all other tactical intelligent fire control sensor systems that require highly accurate azimuth information would take advantage of this capability.

PHASE I: Preparation of a technical report describing and examining the proposed azimuth sensor technology.

The technical report should include the following information: theory of operation; projected performance and operational characteristics; current state of development; and proposed technical approach.

PHASE II: Development of a device which will provide a demonstration of its operating principle and characterization of its performance.

PHASE III: Transition to EMD or DEMVAL for further development and fielding.

COMMERCIAL POTENTIAL: The azimuth sensor would be suitable for a number of commercial systems such as marine and aviation applications, land navigation, search & rescue, and forest service.

NAVAL AIR SYSTEMS COMMAND

N94-172 TITLE: Low-Cost, Lightweight Night Vision Capability for Hand Launched Unmanned Aerial Vehicle (UAV) System

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Human System Interface

OBJECTIVE: To investigate feasibility of developing lightweight, low cost night vision technology for integration into Hand Launched UAVs.

DESCRIPTION: There exists a need to develop and integrate a miniature night vision capability into current and future Hand Launched UAV (HL-UAV) systems to improve mission effectiveness in twilight/night environments. The HL-UAV is capable of performing tactical surveillance and reconnaissance within 5-7- km combat radius. The HL-UAV's nominal operating altitude is between 200-500 feet above ground level. The current prototype system uses a single ground control unit with a Styrofoam/Kevlar composite air vehicle. The electrically powered air vehicle has a 9 ft wingspan, is 6 ft long, and weighs approximately 7 pounds (without payload or batteries). The air vehicle carries the imaging payload (currently a black & white/color camera), electric motor (300 watt Samarium-Cobalt), uplink receiver, downlink transmitter, avionics, and batteries. The ground control unit consists of a pilot's controller, observer's monitor, uplink transmitter, and downlink receiver.

State-of-the-art commercial night vision devices do not meet weight, power, or resolution requirements supporting the need for additional research to develop and prototype a miniaturized system for the HL-UAV. The night vision capability must provide sufficient image resolution to meet military and civil reconnaissance and surveillance mission requirements. The current imaging payload weighs only ounces, and its physical dimensions are approximately 5" x 2" x 2". These are extremely important due to air vehicle payload weight and volume constraints. The current daylight capability is approximately 500 lines of resolution and the black and white camera provides high resolution capability approximately 1 hour before and 1 hour after sunset. Neither camera provides a true night vision capability, however. This restricts the system's operating availability to strictly day/twilight hours, which limits its mission effectiveness. A true night vision imaging capability (e.g., uncooled forward looking infrared (FLIR), image intensifiers, low-light camera) could provide the HL-UAV with an around-the-clock mission capability.

PHASE I: Develop advanced state-of-the-art night vision technology and components that could meet the stated requirements.

PHASE II: Provide prototype night vision payload for bench-level testing. If successful, flight tests in a variety of night time mission environments will follow.

PHASE III: US Navy requirements are to be determined. US Army and National Guard Bureau confirmed their requirements for night vision payloads at several Pointer HL-UAV program reviews and management meetings. US Marine Corps and US Air Force requirements are also to be determined.

COMMERCIAL POTENTIAL: Commercial "spin off" potential is strong. The HL-UAV is already a front-runner for transition to other government agencies, paramilitary operations, and commercial applications. A night vision payload will facilitate transition of the HL-UAV into commercial and civil operations, making the system more flexible and capable. Low cost, lightweight, and low power night vision systems and components, when competitively prices, already have a sizable market in the commercial, civil, and military market places.

N94-173 TITLE: Heat Blankets for Composite Bonded Repair

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Materials

OBJECTIVE: Develop generic heat blankets for composite bonded repair which provide consistent uniform temperature over the entire area of the blanket.

DESCRIPTION: Controlling the variations in cure temperature during hot bonded repair is currently more art than science. Current heat blankets provide non-uniform heating across the repair area often causing under cured or burned repairs. Temperature variations in excess of 50°F from the center of the blanket to the blanket edge exist. Large variations in cure temperature across a repair area produce repairs that are not structurally acceptable. On-aircraft repairs to large structural components are often compromised to attain a balance between under cure and overheating the surrounding structure.

PHASE I: Conduct a study to define requirements and determine feasible methods to maintain uniform consistent temperature/heating for application to field level repair heat blankets. Document results in a final report.

PHASE II: Develop prototype heat blanket and test for use in field repair with portable heat consoles. Document results in a final report.

PHASE III: Implement the configuration for manufacture and use in government and commercial composite repair facilities.

COMMERCIAL POTENTIAL: High quality heat blankets with consistent, uniform temperature distribution have application in the commercial aircraft repair industry.

N94-174 TITLE: LCD Off-Axis Light Leakage

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Human System Interfaces

OBJECTIVE: Identify an optimal solution to the light leakage problem and develop a solution on a prototype LCD unit.

DESCRIPTION: State-of-the-art aircraft are required to perform missions with cockpit ambient lighting environments from full sunlight illumination (over 10,000 fl) to moonless night illumination (less than 0.01 fl). This range of operation requires the use of high performance avionic display technology in order to provide acceptable readability from all viewing positions.

Most new cockpits and cockpit upgrades are now using active matrix LCD technology which provides benefits such as higher contrast, lower power, greater packaging density and enhanced reliability when compared with CRT technology. Unfortunately one of the drawbacks is the increased black-state light leakage off-axis (beyond the viewing cone) which can cause canopy reflections at night. At very large angles this black-state leakage can actually exceed the on-state brightness of video symbology.

PHASE I: Three areas of study will be pursued in this phase:

- Control of backlight emissions (independent of the LCD).
- Control of emission lobe on output (viewer side) of LCD.
- Modification of electro-optical properties of LCD to minimize viewing angle dependence.

An initial system trade study will be performed. Sample optical and LCD elements will be procured and evaluated in terms of on-axis as well as off-axis performance. A final report detailing the results of this effort and recommendations for follow-on work will be generated.

PHASE II: A complete LCD unit will be fabricated which will incorporate the features resulting from the phase 1 activity. This unit will be evaluated and the results documented in a final report.

PHASE III: Incorporate technology into Navy aircraft.

COMMERCIAL POTENTIAL: Auto interior dash lighting.

N94-175 TITLE: Unmanned Aerial Vehicles (UAV) Meteorological Sensors for Atmospheric/Environmental Sensing Applications

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Atmospheric and Space Science/Sensors

OBJECTIVE: Develop a low-cost meteorological (MET) sensors package to be used by UAVs in atmospheric/environmental monitoring operations.

DESCRIPTION: Knowledge of the vertical profile of atmospheric parameters can be an important factor in determining the operational effectiveness of many military and civilian systems. Possible military applications may include: the delivery and use of battlefield obscurants, monitoring and tracking of Nuclear, Biological and Chemical (NBC) agents, adjustment of artillery fire, predicting communication and sensor performance, performing ocean conditions/sea state analyses, and improving military aviation safety, etc. Civilian applications may include: fighting forest fires, monitoring and tracking of pollution, studying and forecasting global weather pattern changes, studying oceanography, and improving civilian aviation safety. A small, low cost, UAV borne MET sensors package capable of measuring and computing the variables affecting atmospheric conditions over a mesoscale sized area in a relatively short time period, could provide more accurate and complete meteorological information than previously available from radiosondes carried aloft by weather balloons. Weather balloons do not give the operator any control in placing sample points, have a limited lifetime utility, and are not normally recoverable. The UAV MET sensors package will become a standard part of the family of UAV's avionics and sensors equipment providing anti-elements warning and self-protection information to the UAV operator. Other MET services and information will be provided to military and civilian users as needed.

PHASE I: Investigate which atmospheric monitoring (i.e., temperature, humidity, pressure, wind, cloud parameters, and atmospheric transmission extinction, etc.) and processing algorithms are required for the UAV MET sensors package to support the various military and commercial applications. Develop a MET sensors package specification and a processing algorithms document.

PHASE II: Develop, test, and operationally demonstrate a UAVMET sensors package for both civilian and military applications.

PHASE III: Produce a UAV MET sensors package which can be integrated into a UAV platform for an operational trial.

COMMERCIAL POTENTIAL: The UAV MET sensors package can provide both civilian agencies and private research organizations with a valuable tool for atmospheric and oceanographic study, hurricane tracking and warning, pollution tracking, and global weather pattern monitoring.

N94-176 TITLE: Integration of Flat-plate X-band and Wideband Antennas for Surveillance/Identification

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Sensors

OBJECTIVE: Design/develop an integrated X-band and wideband antenna suitable for deployment in the nose of aircraft.

DESCRIPTION: A wideband antenna for shipboard use was recently developed at the Naval Research Laboratory. Interest has been shown in developing a similar antenna for tactical aircraft. The design is more complicated because the antenna would be placed in front of and attached to a flat plate X-band antenna. The technique of near-field radiation pattern measurements was originally developed to measure the radiation patterns of large phased-array antennas which would otherwise need to be measured in ranges many miles long. The phase and magnitude of the radiated fields a few wavelengths in front of the antenna are measured. Then the radiated fields at infinity are calculated using Fourier transform techniques. Fourier transform techniques can also be used to calculate the fields in the plane of the radiating aperture. This second technique would be applicable to the problem of integrating the X-band and wideband antennas. Near field measurement facilities, while still rather elaborate, are becoming more accessible with advances in microwave and computer technology.

PHASE I: Obtain a flat plate X-band antenna. Determine a baseline phase and amplitude distribution of the fields in the plane of the aperture. Model wideband elements as thick conduction sheets. Calculate the effect of model wideband elements on field distribution of flat plate X-band antenna and compare with near field measurements.

PHASE II: Investigate wideband element configurations which minimize impact on the X-band fields. If a wideband configuration is found which minimizes the impact on the X-band fields, determine if the residual errors can be compensated for (or at least reduced to acceptable levels) with changes to the X-band antenna.

PHASE III: NAVAIR will transfer this technology to be implemented in improved Identification Systems.

COMMERCIAL POTENTIAL: Very few, if any, private sector applications.

NAVAL AIR WARFARE CENTER/AIRCRAFT DIVISION/WARMINSTER

N94-177 TITLE: Compact, Low-cost, Micropowered Fiber Optic Bypass Switch

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Command, Control, Communications

OBJECTIVE: To develop a compact, low-cost, low-power fiber optic bypass switch to bypass failed or downed nodes in fiber optic data networks.

DESCRIPTION: The Navy is currently developing compact, battery-powered sensor arrays which will be interconnected by fiber optic networks. These networks must be highly reliable and fault tolerant and at the same time consume a small part of the total power and size budgets. To achieve the goals of reliability and fault tolerance the network must be capable of bypassing failed nodes. Currently available active bypass switches are relatively large and power hungry, while passive bypass switches are limited in the number of nodes which may be bypassed, thus decreasing reliability and fault tolerance.

PHASE I: Demonstrate the feasibility of the proposed device. The device should implement a 2x2 bypass switch with a switching time of less than 90 milliseconds. Total insertion loss should be less than 2 Db when used with 50/125 or 62.5/125 micron fiber. Total size of the device should be less than 1 cubic centimeter. The device should be capable of operating from a single 3 Volt supply at a supply current, depending on the switching technique, as described below. A fail-safe mode should be provided in which the device returns to a predetermined state in the event of a power failure. Both latching and non-latching technologies may be considered. For latching technologies peak current drain should not exceed 50 milliamps during the switching time. For non-latching technologies average current drain should not exceed 100 microamps. In addition, the device should be capable of operation after being subjected to shock and vibration characteristic of air deployable systems and over an operating temperature range of -2 to +35 Centigrade (-40 to +55 non-operating).

PHASE II: Develop and demonstrate working model of the bypass switch.

PHASE III: Demonstrate low-cost mass production techniques capable of providing switches in quantities suitable for deploying large numbers of sensor arrays.

COMMERCIAL POTENTIAL: It is anticipated that these devices will find widespread commercial use in networking applications requiring battery-powered remote node operation or in applications where size and power constraints limit the use of conventional networking components.

N94-178 TITLE: Air-Deployable Expendable Multi-Parameter Environmental Probe

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Sensors

OBJECTIVE: To develop an expendable probe that senses and reports a set of relevant ocean environment parameters.

DESCRIPTION: Acoustic and non-acoustic surveillance systems development programs are analyzing system requirements for a number of littoral environments worldwide. Measurements in these environments have shown that the homogeneity that enhanced the predictability of the open ocean environment is no longer available in the littoral scenarios. Accurate prediction of system performance in a given location requires concurrent or recent environmental data because of the high temporal and spatial variability of shallow water environments.

PHASE I: Formulate a design concept and demonstrate feasibility through simulations or subsystem demonstrations. As a minimum the sensor should measure and report a bathythermograph, salinity, turbidity, depth, ambient noise, surface current and current velocity profile. Additional parameters of interest are surface wave height, period and direction, and acoustic bottom properties.

PHASE II: Demonstrate the measurement and reporting functions in situ. Demonstrate the autonomous deployment and operation and the feasibility of air deployment. Assess the affordability of the concept.

PHASE III: Transition the concept to a shallow water air-droppable multi-sensor to replace the functions of the SSQ-36 and SSQ-57B sonobuoys.

COMMERCIAL POTENTIAL: Variants of this sensor may provide a low cost expendable pollution monitor for environmental applications.

N94-179 TITLE: Ultra-Lightweight Ejection Seat

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Materials

OBJECTIVE: Design, fabrication, and testing of ejection seat structure, rails, and aircraft interface using light weight materials

DESCRIPTION: The application of alternate materials on the structural components of the seat can potentially reduce the structure weight by 20 to 30 percent. Research of plausible materials, followed by a trade-off analysis shall establish the final design approach. The analysis shall consider total weight, structural loading, cost, maintenance, repair, interface with sub components, availability of material, mechanical response at temperature extremes, manufacturing techniques, and modification after construction. Technical drawings and data of current technology seats shall be provided.

PHASE I: Develop and provide a detailed conceptual design that can be built and tested. Documentation shall include a phase report, functional description, and technical drawings.

PHASE II: Revise, build and test the conceptual design that was developed in Phase I. Testing shall include ejection tower loading, wind blast loading, and crash loading. Documentation shall include a final report, test reports, and technical drawings.

COMMERCIAL POTENTIAL: New materials for use in the manufacture of commercial seating in automobiles or aircraft.

N94-180 TITLE: Laser Radar for Instantaneous Aircraft Flight Control Correction During Carrier Landings

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Computers

OBJECTIVE: Develop a laser radar that will integrate with aircraft flight control systems to provide instantaneous remote sensing of carrier deck motion and wind shear effect for enhanced pilot control under adverse landing conditions.

DESCRIPTION: Aircraft carrier landings can be potentially hazardous under conditions of intense cross-winds, wind shear or high sea states. A Laser radar can provide realtime data on local wind conditions (relative velocity and direction) and the motion (displacement and rate) of the deck relative to the sea surface. This realtime information can be processed to provide inputs to the aircraft flight control system for enhanced pilot control and automated aircraft response under adverse landing conditions. An innovative approach is desired to develop a compact, low weight, eye-safe laser radar that is designed for aircraft integration, provides a remote sensing capability and includes signal processing algorithms for flight control integration.

PHASE I: Perform an analytical study that identifies critical laser radar performance characteristics, provides a detailed system design, defines flight control integration approach, and determines potential technical risks.

PHASE II: Develop a laser radar prototype system based on an approved Phase I design, and conduct tests to demonstrate prototype system performance capabilities.

PHASE III: Potential use to Navy, Air Force or FAA.

COMMERCIAL POTENTIAL: Potential use as an adverse landing warning or flight control device on commercial aircraft.

N94-181 TITLE: Assessment Model for Environmental Requirements Compliance

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Software

OBJECTIVE: Develop a cost assessment model to identify program costs relating to compliance with environmental requirements.

DESCRIPTION: DoD Instruction 5000.2M requires identification and analysis of potential system inputs on the environment for each alternative during each acquisition phase. Mitigative measures, developed as integral elements of system development, are to minimize adverse impacts throughout the systems life cycle. Costs associated with mitigative measures are not part of existing Life Cycle Cost (LCC) Models, critical to alternative selection. Ability to provide accurate cost estimates to support procurement decisions will become even more critical as environmental regulations become more strict.

PHASE I: Conduct a data search for government and commercial capabilities for modeling environmental compliance costs. Determine which features of which models, including those used by EPA and environmental engineering firms, support Navy weapon system procurement requirements. Develop a critical features listing and flow chart for a notional model for capturing LCC associated with environmental compliance.

PHASE II: Develop, test, and document a computer model that captures LCC associated with environmental compliance in major Naval programs.

PHASE III: The Navy, DoD, and all government agencies are required to reduce/eliminate hazardous materials from their procurements. The LCC model would provide a tool to do so at lowest taxpayer cost.

COMMERCIAL POTENTIAL: Industry has the same requirements for hazardous waste reduction. The cost model would help to identify and minimize compliance costs and improve profitability.

N94-182 TITLE: Aircraft Canopy Trajectory Simulation Model

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Aerospace Vehicles

OBJECTIVE: To develop a computer model that predicts aircraft canopy trajectory after being jettisoned from a stricken aircraft during emergency egress. A first phase shall be considered as the canopy clears the aircraft and a second phase during free flight.

DESCRIPTION: A need exists to simulate the trajectory of an aircraft canopy during an emergency egress or ejection sequence, particularly for new applications. Canopies are currently propelled from an aircraft through the use of a thruster or rocket. Prediction of the trajectory would enable an analysis of potential mid air collision with air crew or ground collision with operations personnel. The canopy trajectory model should consider the initial aircraft conditions and a full six degree of freedom analysis, including aerodynamic effects. The trajectory should cover a wide performance envelope including 0 to 600 KEAS at sea level, and up to M=2 at 50,000 feet altitude.

PHASE I: Provide research and analysis of the most promising techniques and the methodology needed to simulate canopy trajectory.

PHASE II: Develop and provide a validated computer model, through both analytical and experimental techniques, that accurately predicts the trajectories for various ejection scenarios.

COMMERCIAL POTENTIAL: Modeling/simulation can be used for civilian accident investigations.

N94-183 TITLE: Spoken-Language Interface to a Mission Planning System

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Human System Interfaces

OBJECTIVE: Develop a new Human-System Interface to allow a pilot to plan a tactical mission on a mission planning workstation by interacting via a vocal conversation with a speech understanding system.

DESCRIPTION: Pilots should be trained to be proficient in planning a mission, but should not have to be trained to the same level of proficiency in the use of a Unix type workstation. The pilot should be able to dictate a general mission plan, have his dictation accurately recognized and corrected for grammar, and then have his dictation translated into a top level mission plan by a natural language information processing program. The system would then interactively query the pilot in order to develop a more detailed plan. The system should be capable of understanding natural language speech, recognizing large vocabularies, inter-acting with large military databases, high level workstations and interfaces such as helmet mounted displays. The final system should be capable of modifying the mission plan while airborne using a sub-set of the ground based vocabulary.

PHASE I: Demonstrate basic spoken language understanding sub-system. Research and create a development plan for a both a ground based and an airborne voice interactive mission planning system.

PHASE II: Develop and demonstrate a voice interactive mission planning system on a commercial UNIX workstation.

PHASE III: Develop and demonstrate in a simulation an "in-the-air" scenario of the pilot changing his mission and creating an alternate mission plan.

COMMERCIAL POTENTIAL: Commercial aviation versions of this system on a smaller scale could be made available to aid a pilot in planning a cross country flight with the aid of personal computer based system.

N94-184 TITLE: Electrochemical Stripping of Aircraft Coatings

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Aircraft Technology

OBJECTIVE: To develop a non-polluting, non-invasive paint stripping technology for aircraft systems by employing electrochemical techniques of phase separation at metal-polymer interface

DESCRIPTION: The Navy currently uses two types of paint stripping methods: one which is solvent based and has concerns of high VOC and end disposal problems; the second which is now widely used is the plastic media blasting (PMB) - this is least polluting but is concomitant with restriction on use in open air. The PMB stripping must be done in closed system as it involves fragmentation to very small particles which do become airborne and pollute the air, therefore must be contained. Thus a new technology is required which is non-invasive and non-polluting, and can be achieved by simply peeling-off the paint without any extensive use of solvents and/or air blasters.

PHASE I: Initial efforts will be devoted in developing an electrochemical method which can cause interfacial separation of polymer (paint system) from the substrate by addressing the mechanism which causes adhesion. Initially, the choice of substrate would be aluminum alloys. Processes such as hydrolysis or cathodic debonding could be developed by this method to create interfacial separation. Alternatively, a controlled corrosion of the substrate by electrochemical reactions may create a natural peel-off effect. Thus, the first phase of work will deal with development of a technique and proof-of-concept to achieve objectives.

PHASE II: Once the above developed concept (technique) has been proven, then this phase of work will be devoted to extending it to large surfaces and modifying the concept to practical applications. Next the methodology will be extended to several different substrate materials such as steels, composites etc.

PHASE III: In this phase a technology demonstration would be expected on fleet aircraft with an intent that the method is applicable to naval systems and meets all EPA requirements.

COMMERCIAL POTENTIAL: There is a technology gap in the paint stripping area. The developed method would be a dual-use technology with extremely high DOD use and commercial (value) application not only in civil aviation but in other private sectors such as automobiles, bridges, storage tanks, utility structures, ships etc.

N94-185 TITLE: Simulation Environment for the Rapid Prototyping of Advanced Avionics

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Aircraft Technology

OBJECTIVE: The objective is to develop a design for a simulation environment or Avionics Prototyping Tool (APT) that utilizes commercially available elements (computers, modeling tools, and data bases) in a functionally modular architecture. This environment can then be used to design, develop, and demonstrate functionally accurate prototypes of real-time, tactical avionics systems.

DESCRIPTION: Recent advancements in commercially available computing technology have made it feasible to envision a revolution in the way tactical avionics systems are developed. Until now, avionics systems were functionally integrated after the selection and physical integration of hardware components. This approach has led to a variety of factors symptomatic of cost growth: requirements creep, software delays, and expensive hardware tuning during integration. All of these factors have as their source a lack of detailed requirements definition before the commitment to hardware is made. This is where rapid prototyping provides a significant benefit. The APT must include several key capabilities.

-A virtual cockpit, able to simulate a variety of cockpit schemes, either for existing aircraft (F-14), F/A-18, E-2C) or new concepts (AFX, MRF) to allow a man-in-the-loop (MITL) operation/demonstration capability.
-A scenario generator/controller to simulate the external environment including other friendly and hostile platforms (aircraft, missile systems, and ships) in a manual or automatic control mode.
- Data bases to include terrain, terrain features (imagery) and digitized maps.
- Storage/replay capability to enable the post-mission analysis of a particular demo.
- The ability to develop, store, and utilize a library of real-time models. These models will include tactical platforms, tactical sensors, weapons, and groups of the above to a varying fidelity (from "cookie-cutter" quality to performance based on predictions/algorithms).
- Provisions for incorporating selected actual hardware components to replace the software simulations. This would require "gateways" or interfaces between the particular component and the simulation programs.

PHASE I: Feasibility study to concentrate on the refinement of the requirements for APT and the commercial availability of the APT physical and functional building blocks.

PHASE II: Detailed design of the APT system including a breakdown to low-level operational descriptions for both the physical and functional architecture. Physical architecture should include components, interconnects, processing hardware and application software packages, I/O devices, storage devices, control stations, and component sources (vendors). Functional architecture shall include system capability descriptions organized from scenario generation through operation/demo to storage/replay/analysis. Function capabilities must enable the modular insertion and removal of functions as discrete components. This last feature enabling the quick assessment of different combinations of functions in an integrated, tactical avionics system as demonstrated from an aircraft cockpit.

PHASE III: It is anticipated that a number of DOD Agencies, including the Navy, will be pursuing prototyping initiatives on a variety of programs. Of primary interest is the Joint Advanced Strike Technology (JAST) Program. JAST could benefit from an APT approach as the basis of its avionics systems engineering. APT also offers potential in the retrofit and system upgrade arena for platforms such as E-2C and its definition of Block Upgrade Configurations.

COMMERCIAL POTENTIAL: The APT approach could be directly applicable to commercial industry in the development of commercial product prototyping environments for products such as automobiles, aircraft, etc.

NAVAL AIR WARFARE CENTER/AIRCRAFT DIVISION/LAKEHURST

N94-186 TITLE: Landing Signal Officers (LSO) Head Mounted Display with Decision Making Capabilities

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Human System Interfaces

OBJECTIVE: Develop a head mounted display unit for the Navy's LSO which would not only provide aircraft and ship dynamic parameters but would also provide assistance in the aircraft approach decision making process under high workload conditions.

DESCRIPTION: The LSO is responsible for the safe and expeditious recovery of all seabased Naval aircraft. LSOs are stationed on all aircraft carriers and large deck amphibious ships. It is imperative that the LSO have the necessary dynamic information available to them during the terminal phase of aircraft recovery. Carrier LSOs operate in the severe deck environment currently utilizing information available on a very cumbersome 1970's technology Head-up Display while all other LSOs operate in enclosed environments with restricted volumes with absolutely no display no display tools available to them. Technology has and is providing more and more information to those LSOs with a display. This has resulted in increasingly and dangerously high workload situations. Thus a decision making aid would help the LSO in performing his critical tasks.

PHASE I: Determine the feasibility of such application. Also determine what information parameters are required by the LSO and how LSOs formulate decisions. Develop software to address these issues. terminals involved.

PHASE II: Design, fabricate and produce a breadboard display system that would interface with the LSO Training Simulator or a shipboard LSO Workstation.

PHASE III: Commercialize technology to various users which require continuous information; such as bus terminals, maintenance depots, users of building blue prints, flight deck landing officers, maintenance crews, and etc. Also transition the technology to other agencies for use in air traffic control situations.

COMMERCIAL POTENTIAL: This technology has application in the private sector such as building maintenance crews, various repair crews, attendants and inspectors for mass transportation terminals, on-site training aids, et cetera.

N94-187 TITLE: Automated Accurate Aircraft Weighing System (A^3WS)

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Aerospace Vehicles

OBJECTIVE: To develop the capability of acquiring accurate aircraft weight on the carrier's flight deck with alacrity, under all weather conditions.

DESCRIPTION: Aircraft weight is a critical factor in the setting for catapult launch. This factor plays a crucial role to the service life of seabased naval aircraft. Currently, aircraft weights are estimated on the flight deck by summing up the aircraft's ordnance, fuel, and factory measured structural weight.

PHASE I: Investigate and develop the feasibility of acquiring aircraft weight prior to launch for catapult settings. The candidate systems must be employable under all carrier's environments. Develop and identify specifications for sensors that are to be incorporated without hindering any of the current flight deck's operations.

PHASE II: With results gathered from Phase I, develop a prototype system and perform testing to demonstrate the feasibility of such a concept.

PHASE III: Successful concept will be demonstrated, further development and fleet testing for carrier application is anticipated.

COMMERCIAL POTENTIAL: There exist great commercial potential for such systems that could acquire vehicle weights with great alacrity. Such applications could be used for determining vehicle weights before they enter tunnels or bridges and etc.

NAVAL AIR WARFARE CENTER/AIRCRAFT DIVISION/PATUXENT RIVER

N94-188 TITLE: Volumetric Airwake Measuring Equipment

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop instrumentation to make accurate 3-D volumetric airwake measurements for ships, off-shore oil rigs, roof-top heliports, and commercial airports.

DESCRIPTION: The ship airwake is the most important variable in the aircraft shipboard landing task. It is also probably the most difficult parameter to measure and to model for real time pilot-in-the-loop shipboard landing simulation. In the past, engineers have used hand-held anemometers and mobile masts with anemometers to make airwake measurements. The mobile masts improved spot airwake measurements, but they are bulky and require considerable effort to assemble, move around on deck, store, and disassemble. Improved instrumentation is required to measure the airwake volume over ship flight decks, off-shore oil rigs, and roof-top heliports, as well as, approach/departure zones to commercial airports. The equipment should provide accurate 3-D airwake data for a point source and for a specified air volume surrounding the flight structures, for steady and turbulent airwake components. The equipment should be readily transportable to and from the test site, compatible with ship equipment, ship motion, ship EMV, and hostile maritime environment.

PHASE I: Review rotorcraft/ship flight test and simulation programs with respect to ship airwake measuring and modeling. Review airwake measurements at off-shore oil rigs, roof-top heliports, airports, and related structures. Define status of all likely systems/methods for measuring the airwake, describing strengths, weaknesses, relative risk, and limitations of each approach. Propose the best airwake measurement system/method, defining approach, accuracy, reliability, and supportability.

PHASE II: Develop the airwake measuring system. Perform analysis, laboratory and ground-based check-outs, calibrations, and useability/reliability/maintainability evaluations. Support one at-sea airwake measurement test, including test planning, data acquisition, data reduction, and reporting.

PHASE III: Use the equipment to measure the airwake of a commercial off-shore oil rig.

COMMERCIAL POTENTIAL: The volumetric airwake measuring equipment could be used to measure the airwake at a commercial roof-top heliport and to measure downdrafts at commercial airports.

NAVAL AIR WARFARE CENTER/WEAPONS DIVISION

N94-189 TITLE: High Visibility Signal Cartridge for Practice Bombs

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Training Systems

OBJECTIVE: Develop a highly visible Signal Cartridge to be used with Practice Bombs, that will not initiate bomb range fires or produce other harmful environmental hazards.

DESCRIPTION: Signal Cartridges provide a means for marking Practice Bombs point of impact when scoring bomb drops for pilot training. The current high visibility signal cartridge, MK 4 MOD 3, uses Red Phosphorus to produce smoke and flame for signaling. This method, on some occasions, produces fires on the bombing ranges. The Military services require a signal that is highly visible during night time exercises that does not produce environmental hazards. Nine requirements for the signal are as follows: 1) Provide a system to instantaneously mark impact point of Practice Bomb, and is detectible from a distance not less than one mile. 2) Provide an emission long enough to be recorded and provide singular discrimination between succeeding impacts. 3) Provide a signal within 1.6 milliseconds of surface impact of Practice Bomb. 4) Be encased in a cylindrical cartridge 0.85 inches in diameter and approximately 6 inches long. 5) Not contain any material which is toxic, radioactive, or environmentally harmful. Must not require any Ozone Depleting substances for manufacture. 6) Not explode or separate when subjected to five foot drop test of MIL-STD-331, test III, procedure 2. 7) Pass vibration test of MIL-STD-810, method 514.2, procedure I, figure 514.2-2, curve J. 8) Must not initiate fires. 9) Low unit cost.

PHASE I: Demonstrate feasibility and producibility of proposed signal method. Provide prototypes.

PHASE II: Develop and conduct test program to demonstrate that signal method meets requirements. Deliver all test data to U S Government and 40 prototypes for operational evaluation.

PHASE III: Phase II results will be disseminated for evaluation/approval and implemented as practicable.

COMMERCIAL POTENTIAL: May have potential as marker location device.

N94-190 TITLE: Adaptive Wavelets

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Software

OBJECTIVE: Explore and develop software to implement wavelet expansions that give arbitrary tilings of the time-frequency domain.

DESCRIPTION: Recently, there has been much development of wavelets and their generalizations. Wavelets coefficients produce local estimates of the region in the time-frequency plane where most of the signal energy is contained. Presently, wavelet waveforms with a fixed time-frequency tiling pattern are used in order to best match the signal structure. What is desired is a time varying filter bank that can automatically select the best match to the local signal structure and transition between different wavelets.

PHASE I: The available options for adaptive wavelets with an arbitrary time-frequency tiling will be addressed. Among the selected alternatives substantial algorithm maturity must be demonstrated.

PHASE II: Algorithms and software will be developed and applied to select set of radar signals and infrared images with structured or patchy clutter. Both synthetic and measured signal must be utilized.

PHASE III: A system demonstration utilizing weapon system sensors and wavelet processing with development of fieldable weapon system hardware/software.

COMMERCIAL POTENTIAL: Adaptive wavelet filters could be applied in voice recognition, in medical imaging, digital cellular phones and audio and image compression.

N94-191 TITLE: Integrated Image Processing Focal Plane Array

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Computer Science

OBJECTIVE: The objective of this work is to develop a focal plane array that is combined with a massively parallel processor on a common substrate, preferably in a 3 dimensional stacked configuration. It should be capable of supporting processing methods such as neural networks, fuzzy logic networks, wavelet processing and/or all kinds of conventional parallel image processing techniques.

DESCRIPTION: Advanced optical guidance integrated fuse concepts require very high speed image processing methods to extract the pertinent information to perform both the guidance and fuzing functions. Massively parallel processing methods have the highest potential for providing the data rates needed to perform these functions for future systems. The primary bottleneck to achieve these rates with presently available devices is the data transfer between the focal plane array and the massively parallel processor. An integrated stacked configuration may eliminate this bottleneck.

PHASE I: Develop an integrated image processing focal plane array concept. Determine and document the capabilities and limitations of the proposed fabrication method. Propose and specify the capabilities of a demonstration model.

PHASE II: Build, test and document the resultant characteristics of the proposed demonstration model.

PHASE III: Upon successful completion of phase II, the resulting technology will be incorporated into several major Navy and other services programs, such as JSOW, JDAM, Javelin and second generation FLIRS.

COMMERCIAL POTENTIAL: This product would be useful in any application which requires extensive image processing, especially at high speeds. Security systems which may need personal recognition may require this capability. Quality control of production items which may be measured or characterized by image processing techniques may require the speeds attainable with this device. Also, automated production that requires a physical reorientation of components at high speeds could use this device.

N94-192 TITLE: Low-Profile Broadband Radiating Elements

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Command, Control, Communications

OBJECTIVE: Develop a broadband (2-18 GHz) radiating element design suitable for operation with low-profile active electronically steered array (AESA) antennas.

DESCRIPTION: Inexpensive, dual polarized, broadband (2-18 Ghz) radiating elements having integral circulators and a total depth less than one inch are needed for future low-profile AESA antennas. Current broadband (flared notch) radiating elements with circulators require about twice this depth. Operation over the 2-18 Ghz band is difficult to achieve and increases the cost of the circulator. Future broadband AESAs will require this capability at a production cost well under $100/element.

PHASE I: Develop radiating element/circulator design approach and layout; conduct computer performance simulations; report results.

PHASE II: Refine Phase I design; fabricate and test a radiating assembly based on the design; report results.

PHASE III: Combine Phase II radiating element technology with advanced transmit/receive (T/R) circuitry packaging technology currently being developed by Advanced Research Project Agency initiatives and other funding. Develop a low-profile demonstration AESA suitable for aircraft side array and missile applications.

COMMERCIAL POTENTIAL: The low-profile packaging technology could be useful in a variety of commercial communications applications, including satellite broadcast systems and commercial aircraft. Broadband applications are primarily defense related at this time.

NAVAL AIR WARFARE CENTER/TRAINING SYSTEMS DIVISION

N94-193 TITLE: Constructivist Learning Approaches to Training Decision-Intensive Tasks

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Training Systems

OBJECTIVE: To investigate alternatives to traditional instructional design practices for training programs that are heavily weighted with cognitive learning requirements involving decision making.

DESCRIPTION: Traditional instructional design practices center around identifying and addressing a hierarchy of skills and knowledge. However, the demands of some tasks require training programs that are more cognitive in nature. For example, the aviation community talks about training "head skills" as a component of aircrew coordination training. Traditional instructional design with an emphasis on measuring procedural outcomes is an awkward fit for many of these types of training demands. Constructivist learning theory postulates that ready recall of information and smooth execution of procedures do not guarantee active use of knowledge or skills, as the learner later strives to cope creatively with new situations. On the contrary, there is evidence that a drill-and-practice regimen may yield knowledge and skills more contextually welded to particular circumstances, and less easily transferred. Efforts are needed to investigate the applicability of constructivist learning approaches to particular Navy training requirements, such as Aircrew Coordination Training (ACT) and various Combat Information Center (CIC) mission operations.

PHASE I: Examine the literature on constructivist learning approaches and identify areas of research applicable to improving Navy training. Generate a report with recommended hypotheses to be tested and methodology to be used.

PHASE II: Incorporate constructivist learning approaches and test selected hypotheses identified during Phase I.

PHASE III: Based on test result from Phase II, incorporate approaches in additional courses, both Navy and commercial.

COMMERCIAL POTENTIAL: Results of Navy R&D in ACT are transitioning into civilian aviation applications. This effort is a candidate for similar transition. It may also be used in training for nuclear power plant operations, in training responses to emergency medical situations, etc.

N94-194 TITLE: Electroluminescent Displays for Helmet-Mounted Displays

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Human Systems Interfaces

OBJECTIVE: To develop both monochrome and color high resolution, high brightness, lightweight, miniature, active matrix electroluminescent (AMEL) displays for military and commercial HMD applications. The following minimum display performance will be required:

	Monochrome	Color
Resolution	1280h x 1024v	1280h x 1024v
Lines per inch	1000	1000
Display Size	1.5"h x 1.5"v	1.5"h x 1.5"v
Display Thickness	0.15"	0.15"
Pixel Size	24um x 24um	24um x 24um
Brightness	15 Fl - 500 Fl	15 Fl - 100 Fl
Power	150mw - 2w	15mw - 2w
Contrast Ratio	100:1	100:1
Number of Colors	1	4096
Grey Scale/Color	64	16
Data Rate	60 Hz	60 Hz
Weight	6 grams	6 grams

DESCRIPTION: Helmet Mounted Display (HMD) Technology will be utilized in future deployable or transportable carrier based Out-the-Window simulators and Virtual Environment Training in the commercial/military areas. Current limitations in commercially available HMDs either utilize light valves which require heavy optics or low resolution monochrome or field sequential color CRTs causing the HMDs to be bulky and heavy in weight and increasing the probability of neck and head strain. Current flat panel STN-LCD and ACTIVE Matrix TFT-LCD disadvantages; difficult and expensive to manufacture in a small display size; cannot stand high vibration and temperature conditions and poor viewing angles. Electroluminescent Displays advantages over LCDs are: Higher Resolution in a small display size, higher luminance, wider viewing angle and better vibration and temperature endurance.

PHASE I: Perform a preliminary concept design which conforms to the above specifications.

PHASE II: Finalize design and construct prototype which will be available for testing at Navy Air Warfare Center TSD.

PHASE III: Inclusion into future helmet mounted display military training and commercial virtual reality systems.

COMMERCIAL POTENTIAL: Virtual reality systems.

N94-195 TITLE: Tools for Creating Real-Time, 3-D Computer Graphic Environments

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Software

OBJECTIVE: Develop a set of user-friendly graphical tools that could be used to rapidly create 3-D environments and operate those environments in real-time utilizing a subset of the same software.

DESCRIPTION: Various government and civilian organizations are examining the applications of virtual reality. Each application requires extensive modelling by highly trained personnel to create the environments for the various applications. A set of icon based development tools and a integrated playback system that did not require specific graphics programming knowledge would allow rapid development of environments. Elements within the environment could be controlled by events within and external to the software (e.g. joystick, position sensor, etc.). The design should be based on low cost hardware and easily allow for the integration of external hardware and software control inputs to manipulate the tool-created 3-D world.

PHASE I: Develop a modularized hardware and software architecture that could support the real-time, 3D tool set.

PHASE II: Develop the run-time graphics module and basic development tools to create interactive, real-time virtual environments.

PHASE III: Distribute two package sets for evaluation. One set to include the design tools and run-time software and the other set to on include the run-time software with previously created environments for evaluation.

COMMERCIAL POTENTIAL: Several packages currently exist to model 3-D virtual environments. However, they are independent of the run-time software. Two potential markets could open up with this technology. One, the user of previously created environments (it could be a simple game) that wasn't interested in creating them and; two, the developer market with the ability to share icons (e.g. model sets such as planes, human models, etc.) to create these environments.

NAVAL SEA SYSTEMS COMMAND

N94-196 TITLE: Permanent Magnet Variable Speed Drives

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Surface/UnderSurface Vehicles

OBJECTIVE: Design and construct affordable permanent magnet variable speed drives for auxiliary applications in US Navy ships.

DESCRIPTION: Permanent magnet (PM) variable speed drives (VSD) promise favorable ship impact if they can be substituted for hydraulic systems and actuators in US Navy ships. Other uses include HVAC and the whole range of small motor applications. PM motors are currently much more expensive than induction motors of the same horsepower, and the addition of variable speed controllers raises VSD cost much higher than equivalent power, across-the-line-start, constant speed induction drives. This task will investigate solutions to the affordability problem and construct several PM VSD to verify the results of study

PHASE I: Conduct a study to determine the cost effectiveness of PM VSD in auxiliary applications in US Navy ships. The following should be considered in the study: (1) level of technology today and in the near future (within 5 years) with regard to PM materials and power conditioners, (2) the impact of standardization of equipment and system simplification, (3) the reduction of piece part count, (4) the impact on fuel efficiency of the ship, (5) the impact on maintenance and operational flexibility, (6) the impact on military effectiveness metrics such as quieting and survivability, (7) the impact on component, module and ship size/weight, (8) the impact on ship producibility, and (9) the impact on the US industrial base. Design To Cost targets, a desirable range of applications and preliminary design detail should be established.

PHASE II: Design several PM VSD from the results of the Phase I study.

PHASE III: Construct prototype PM VSD for ship qualification.

COMMERCIAL POTENTIAL: While the Phase I effort will quantify the effect on the US industrial base, PM VSD are already being used in commercial applications such as large buildings.

N94-197 TITLE: Membrane System for Graywater/Oily Waste Water Treatment

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Chemistry

OBJECTIVE: To develop a membrane system suitable for concentrating shipboard graywater and/or oily water wastes.

DESCRIPTION: Navy ships generate large volumes of graywater and secondary oily wastes which will be required to be treated prior to overboard discharge. Graywater, which is made up of shower, laundry and galley wastes, normally has a high Biological Oxygen Demand (BOD) level which must be reduced prior to overboard discharge. It contains surfactants, lint, oils and fats and food wastes. Secondary oily wastewater, typically from ships' bilges and processed through a parallel plate oil water separator, contains trace concentrations of oil (<20 ppm), organic substances and heavy metals (mostly copper ions). Both waste streams contain high levels of suspended solids. The Government is soliciting for the development of a membrane system or systems using ultrafiltration or direct osmosis for the concentration of one or both of these shipboard liquid wastes to over 95%. These systems should be capable of producing an effluent with a BOD and suspended solids level of less than 30 ppm and a 95 percent rejection of heavy metals, oils, surfactants and other hydrocarbons.

PHASE I: Identification/modification/synthesis of a membrane composed of an appropriate organic polymer which possesses non-fouling characteristics and is maintainable when concentrating graywater and secondary oily wastes. Demonstrate feasibility of membrane system to successfully treat graywater and/or secondary oily wastes.

PHASE II: Develop and demonstrate efficacy of prototype membrane module in the concentration of actual graywater and secondary oily water wastes.

PHASE III: Develop commercial type membrane graywater treatment system.

COMMERCIAL POTENTIAL: Numerous on-site wastewater treatment systems would benefit from a membrane system which is non-fouling and possesses an increased processing rate, longer cleaning intervals and a longer membrane life.

N94-198 TITLE: Internal Fault Detection/Classification System for Permanent Magnet Machines

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Propulsion

OBJECTIVE: Design and construct an internal fault detection/Classification system for PM Machines

DESCRIPTION: Since the field of a permanent magnet (PM) machine cannot be turned off, any shaft rotation will induce voltages and currents into the stator windings. If stator winding faults occur, serious damage to the machine may result. Segmented stator windings are an effective defense but require timely detection of the fault and subsequent continuous coordination of the load placed on the faulted segment. PM machines may continue degraded service with several classes of faults by isolating the faulted winding segments, given timely fault detection and subsequent coordination of loads in the faulted segments. Large PM machines may include over 40 segments and require the isolation/coordination of 40 segment loads, including an indeterminate number in a faulted condition.

PHASE I: Design a fault detection/classification system for a PM generator and PM motor, both in the range of 25,000 hp. The design must interface with control systems at the supervisory and power generation (modular) levels, and accommodate the service and no-damage fault tolerance thresholds (times) of current design PM machines of the ASMP Program and the reduced fault tolerance thresholds of future, larger PM machines.

PHASE II: Build the Phase I system and integrate it with PM machines being built by ASMP (SEA-03R22). Demonstrate the ability to detect faults and coordinate isolation, simultaneously, in up to 4 segments.

PHASE III: Qualify for US Navy shipboard use the system

COMMERCIAL POTENTIAL: Such a fault detection/classification system will undoubtedly be adopted for use by the commercial power generation industry, as well as industrial users of large and expensive electric machines

N94-199 TITLE: Affordable Disconnect Device for Large HP Permanent Magnet Motors

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Surface/Undersurface Vehicles

OBJECTIVE: Design and construct an affordable disconnect device for large horse power PM motors

DESCRIPTION: Electrical isolation of PM motors may be necessary due to faults either in the motor or motor inverter units. Lack of isolation increases risk of damage or injury. Permanent magnet (PM) motors used for ship propulsion are connected to a propeller shaft that will continue to turn whenever the ship is moving; as long as the shaft is turning an AC voltage will be present at the terminal windings. Disconnection of the shaft from the motor while the motor is turning may involve costly devices.

PHASE I: Conduct a trade-off study covering the following disconnect options: (1) do nothing, (2) add clutch, (3) use disconnect flange, and (4) mechanical brake. Take into account design of motor inverter, required jacking gear and effects on other systems in the ship.

PHASE II: Design and build a prototype for the selected disconnect device for application in a nominal 25,000-hp shaftline.

PHASE III: Systems Command follow-on effort anticipated.

COMMERCIAL POTENTIAL: When PM electric drive begins to be installed in US Navy ships, these devices will need to be supplied. Certain commercial ships will also require them.

N94-200 TITLE: Image and Data Management System

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Electron Devices

OBJECTIVE: To design and develop an electronic (non-film based) system for archiving, retrieving, displaying, reviewing, managing, and reporting and printing image, numerical, spectral, text and other data from electron and optical microscopes.

DESCRIPTION: An Image and Data Management system shall be developed based on analog and/or digital storage of images and data on computer-based management. The System shall address several issues including cost, convenience of use, speed flexibility, and quality. The system shall eliminate the use of hard copy material such as film and Polaroid™ materials.

PHASE I: The contractor will develop and evaluate one or more designs for the proposed system. The design(s) will address, at a minimum, major technical hurdles and their implementation; performance targets including retrieval speed, storage capacity, display and hard copy image quality; cost; and data management capabilities. A partial implementation of one or more candidate designs will be presented in sufficient detail to demonstrate feasibility.

PHASE II: During Phase II the contractor will implement and demonstrate a complete prototype system for one of the systems developed and reviewed under Phase I.

PHASE III: Upon successful completion of Phase II, systems would be of immediate benefit to all Navy, DoD or other government installations doing film-based microscopy in reducing film costs and toxic waste production.

COMMERCIAL POTENTIAL: Strong commercial potential exists. The system is expected to have immediate benefits for any industrial, commercial, university, government or other laboratory which does a substantial amount of film-based optical or electron microscopy.

N94-201 TITLE: Advanced Lightweight Influence Sweep

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Materials and Processes

OBJECTIVE: Develop a liquid-cryogen-free, high temperature superconducting magnet system operating at a field strength of 1 to 3 Tesla and cooled to a temperature of 20 deg Kelvin or higher without the need for liquid Helium or Nitrogen. Demonstrate the operating performance and reliability of the magnet system for applications to magnetic mine sweeping, high efficiency motors and generators, and magnetic energy storage.

DESCRIPTION: The development of high temperature superconductors has progressed to the point where long lengths of conductors having predictable performance characteristics can be produced. Though these conductors operate at relatively low current densities, they have the capability of operating at temperature above the temperature limits of conventional superconductors. Superconducting magnets, wound with high temperature superconductors and cooled with cryocoolers, can operate without using and liquid cryogens eliminating a major application barrier associated with low temperature superconducting magnets.

PHASE I: Design a superconducting magnet system consisting of a magnet wound with high temperature superconductor which is conductively cooled with a cryocooler refrigerator. The magnet will be designed to produce a magnetic field of 1 to 3 Tesla at an operating temperature of 20 deg K or higher. The design study will include determining the effects of winding and Lorentz force stress upon conductor performance, developing conductor splicing techniques, and magnet quench protection.

PHASE II: Fabricate the high temperature superconducting wire and magnet. Design and fabricate the magnet cryostat and assemble the magnet, cryostat, and cryocooler system. Measure and demonstrate system operating performance and reliability to full field and current.

PHASE III: Transition the high temperature superconductor and magnet technology developments to Navy minesweeping and electric propulsion programs.

COMMERCIAL POTENTIAL: The technology has commercial application potential in the areas of high efficiency electric motors and generators, magnetic resonance imaging system, magnetically levitated trains, and magnetic energy storage.

N94-202 TITLE: Surf Zone and Craft Landing Zone Obstacle Clearance

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Conventional Weapons

OBJECTIVE: To develop concepts, equipment, and/or techniques to breach transit lanes through defensive (non-explosive) obstacle complexes located in the Surf Zone (0 - 10) and Craft Landing Zone on the beach.

DESCRIPTION: Technologies may include any mix of explosive or non-explosive techniques. Concepts should emphasize high payoff for rapid obstacle clearance, as well as near-term (1995 - 2000) and far-term (2000 - 2010) applications.

PHASE I: Identify potential concepts, means of deployment and cost per system for obstacle breaching mission. Quantify capabilities of each concept.

PHASE II: Demonstrate optimum concept(s) from Phase I study, showing performance objective is achievable and capable of being deployed from existing fleet assets.

PHASE III: Execute full scale system design and build prototypes for developmental and operational test and evaluation. Demonstrate system readiness for initial operational capability by demonstrating acceptable performance, reliability, maintenance, training procedures, and all other logistic support requirements.

COMMERCIAL POTENTIAL: It could be applicable in the reclamation of abandoned industrial sites located in coastal areas.

N94-203 TITLE: Submarine Combat System C^4I Interoperability

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Command, Control, Communications

OBJECTIVE: Develop methods to improve the interoperability and integration of the submarine force with other Naval forces, as well as with other Services and Special Operations Forces.

DESCRIPTION: The Navy has shifted its focus from a global threat to one encompassing regional challenges requiring emphasis on joint and combined operations. This new strategic direction, which shifts from open-ocean warfighting "on the sea" toward joint operations conducted "from the sea", most acutely affects the Navy's submarine force. The submarine force needs to evolve its C4I capability to achieve maximum integration of its anti-surface warfare, strike warfare, mine warfare, and special operations capabilities with those of other forces. An analytical methodology is required that addresses and evaluates the effectiveness of the submarine vis-a-vis its prospective roles and missions as the submarine force enhances its capabilities for joint operations, and as they are further tailored to support National needs.

PHASE I: Develop a model of submarine force/other forces C4I interoperability; identify and baseline current capabilities, as well as proposed areas of future integration. Develop a dynamic, simulation/stimulation and scenario-driven techniques to evaluate alternative hardware configuration, and assess the relative contributions of hardware options (including new, developmental, COTS and NDI systems and equipment, as appropriate) in order to optimize information dissemination and interoperability among submarine combat subsystems.

PHASE II: Expand and enhance the Phase I model capabilities to support New Attack Submarine systems, and develop direction and decision-making, resource allocations, engineering design specifications, and performance assessment functions. Subject information transferred across New Attack Submarine subsystem boundaries to logical simulation and physical models to evaluate information technology applicability to New Attack Submarine systems development.

PHASE III: Produce a submarine force C4I interoperability model that implements methods demonstrated in the Phase II effort.

COMMERCIAL POTENTIAL: Communications resource optimizing techniques and factory process automation.

N94-204 TITLE: Infrared Window Material Improvement

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Material/Sensor

OBJECTIVE: Develop new materials for use in Infrared (IR) Sensor Windows which will exhibit greater resistance to thermal stresses than those currently available. IR bandpass characteristics must be preserved.

DESCRIPTION: The Navy is currently developing several systems critical to the National Defense posture which employ Infrared sensors on board guided missiles. The current applications can expose the protective windows of these sensors to considerable heat loading limitation of existing window material thermal stress characteristics impose significant restrictions upon system capabilities.

PHASE I: Develop a plan to investigate alternative technologies and materials to be used in the IR Window applications. Proceed with analyses and studies to determine the best approach to replacing existing window materials with improved designs. Solutions must meet the functional needs of the IR Sensor as well as requirements for affordability and producibility.

PHASE II: Pending the successful outcome of Phase I efforts, develop and demonstrate improved IR Window technology.

PHASE III: Government-sponsored follow-on R&D is anticipated.

COMMERCIAL POTENTIAL: The new technology may be applicable to design of commercial aircraft sensing systems.

N94-205 TITLE: Growth of Ce:LiCAF/LiSAF for Tunable Laser Operation in the Ultraviolet

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Materials/Sensor

OBJECTIVE: Develop growth parameters for boules of Ce:LiCAF/LiSAF and isomorphs for fabrication into high quality laser rods for operation as a frequency-agile, ultra-violet laser source.

DESCRIPTION: Recent research has indicated that the substitution of rare earth ions into the colquirite structure is feasible. Experience from the growth of Cr:LiCAF indicates favorable growth conditions such as low melting points and near unity distributions of the dopant ion. The rare earth ion should occupy the octahedral Ca site in the LiCAF host. In chloride compounds, rare earth ions occupying octahedral sites have exhibited very long lifetimes, which would be favorable for energy storage applications. The Ca site is approximately 1.14 A, which would comfortably accommodate in ion such as Ce, which has an ionic radius of 1.15 A. Recent work by Dubinski, et al, from Kasan State University in Russia has shown that doping of LiCAF with Ce ion is interesting since excitation of the 5d excited state can be achieved with a quadrupled YAG laser at 266 nm, followed by the 5d-4f emission at approximately 280-300 nm. This emission could lead to a tunable UV, laser source, as has been described recently in preliminary reports from Dubinski. This supports ONR/NRL Code 5641 Accelerated research Option on tunable solid state lasers.

PHASE I: Evaluation of the potential to grow high quality boules of Ce:LiCAF/LiSAF. Phase I of such a program would require several boule growths in order to understand the growth characteristics of the Ce-doped crystal. The final portion of Phase I will be to investigate the spectroscopic properties of Ce doped materials, such as emission and absorption cross-sections and upper state level lifetimes. Other such properties to investigate would include the photochemical stability of this material under the uv excitation.

PHASE II: Growth and fabrication of Ce:LiCAF/LiSAF for frequency agile, ultraviolet laser emission. Work with laser researchers to optimize dopant densities and characterize laser output.

PHASE III: The Contractor will grow larger and higher quality crystals and ingots. These materials will be grown with the optimized rare earth (or other) dopant concentrations required to produce power and tunability objectives suitable to application in UV solid state lasers. Phase III will include minimum production capability of crystals suitable for operation in 50 to 100 laser devices.

COMMERCIAL POTENTIAL: This will be the first all solid state tunable UV laser, providing the compactness, reliability, and efficiency necessary for field work. Several communications applications exist for this tunable UV source and additional applications include remote sensing of biological and chemical species. The region around 290 nm is ideal for this remote sensing application since the contaminates have absorption peaks in this region.

N94-206 TITLE: Fiber-Optic Environmental Sensor for ASW/ASUW Applications

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop torpedo environmental sensor with current state-of-the-art sensor technology and miniaturization. The data will update torpedo tactical software executing an attack. The sensor will be required to meet all safety and reliability criteria for ordnance and provide performance in specific tactical scenarios

DESCRIPTION: Address production issues for the proposed sensor to ensure that current and future weapons are safe, reliable, procurable and most importantly capable of defeating any sub, in any water conditions. A capability to incorporate advanced fiber optic sensor technology is required. The new sensor must be capable of measuring temperature, pressure, under water sound velocity and function in various scenarios for the common torpedo of the next century , including missions in ASW, ASUW and Special Operations.

PHASE I: The contractor will examine the constraints of the existing LWT envelope and the specified accuracy requirements; the characteristics of currently available FO sensors (including packaging, power, and performance); and recommend a prototype design for fabrication

PHASE II: The contractor will repetitively re-design (if necessary) and fabricate and test prototype sensor(s), first under laboratory conditions and then in the water, until the feasibility of the selected approach is demonstrated.

PHASE III: Production of design for implementation in torpedoes

COMMERCIAL POTENTIAL: Medicine, Aircraft navigation systems, manufacturing, building and laboratory environmental control

N94-207 TITLE: Propulsion Capability for 3-Inch Submarine Countermeasures

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Surface/Undersurface Vehicles

OBJECTIVE: Develop propulsion design to provide mobile capability for 3 inch submarine countermeasures.

DESCRIPTION: Mobile acoustic countermeasures provide a distinct tactical advantage against sonar and torpedo threats. Of all the mobile countermeasures developed,only the MOSS is actually in service, and it is expected to be phased out within two years. As a result the submarine community will be left without mobile countermeasures for at least 10 years. Development of an inexpensive mobile countermeasure will provide a cost-effective alternative which will restore this capability to the submarine fleet.

PHASE I: Develop a preliminary design based on launch dynamics and tactical requirements which will include baselines for propulsion, acoustics, electronics, hull and structure, guidance and control systems.

PHASE II: Build and test three demonstration prototypes which will implement the baselines formulated under Phase I. The device will be a 3-inch diameter torpedo jammer capable of speed of 20 knots for three minutes.

PHASE III: Refine tactics and deployment scenarios and compile acquisition and program documentation to support procurement of concept.

COMMERCIAL POTENTIAL: Foreign military sales; fishing accessory.

NAVAL SURFACE WARFARE CENTER/CARDEROCK DIVISION

N94-208 TITLE: Shipboard Sensors for Fuel and Oil

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop new sensors for in-place monitoring the total acid content (to be measured as Total Acid Number (TAN)) of lubricating oils, hydraulic fluids and fuels, and/or for quantitative detection of moisture and water contaminants, in shipboard fuel and oil systems.

DESCRIPTION: New shipboard maintenance concepts are based on the operating condition of fuels and lubricants. Shipboard safe instruments are needed by the Fleet to accurately and rapidly test the acidity/alkalinity of shipboard oils and fuels. Development of sensor-based TAN detection equipment is directly dependent on finding a suitable inexpensive TAN sensor, fabricated with materials whose physical and chemical properties respond predictably and accurately to oil acidity changes. Several promising materials have recently been explored for this purpose and are subject of present studies. New sensors will be used to in-situ accurately measure water/moisture levels over the complete range of contamination concentrations found in both fuel and shipboard lubes/hydraulic fluids. Presently, there are at least three different types of water-specific sensors that may be considered for development.

PHASE I: Explore new sensor technology that would safely characterize fuels and lubricants and choose which sensor(s) could be inexpensively employed in commercial instrumentation.

PHASE II: Build two small prototype instruments for shipboard use. Conduct statistical operational analysis comparing new instruments to ASTM measurements.

PHASE III: Manufacture new instruments and supply to the Fleet, as required.

COMMERCIAL POTENTIAL: The new sensor would replace current laboratory testing and will revolutionize fuel and oil analysis in marine and land-based systems. Financial payback would be enormous since costly and time consuming laboratory testing (e.g., titration) would be eliminated.

N94-209 TITLE: Infrared Coating

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Materials and Structures

OBJECTIVE: Develop a coating system, easily and inexpensively applied, that exists in thermal equilibrium with surrounding air temperature, has controlled emissivity, is opaque to IR radiation, does not perturb radiation in the microwave region and meets the standard color requirements of Navy haze gray paint. Coating must be applicable to rubber and other polymeric materials and on metallic surfaces without peeling and cracking in a marine environment. Coating must be easily applied, preferably in a one step method.

DESCRIPTION: This coating treatment must be transparent in the microwave region. The problem of absorbing, storing and reradiating thermal energy in the coating and the substrate which the coating protects will be addressed. Experimentation in particle size, novel use of ceramics as pigments, electrically insulated highly conductive particles, liquid crystals designed for quick response time of energy absorption/dissipation, etc. is encouraged. Resultant coating must not store thermal energy that results in heating to a higher temperature than its surroundings. The coating must prevent solar heating of underlying material and come to thermal equilibrium with its surroundings within a short time frame. Prolonged emission of thermal energy after the surrounding temperature has cooled must be prevented. Investigation of alternatives and novel methods to solve the problem of thermal control may be necessary.

PHASE I: Identify pigments and other materials to be used in formulation.

PHASE II: Formulate system into an easily applied coating.

PHASE III: Scale-up production for economic delivery of coating.

COMMERCIAL POTENTIAL: Control of solar heating/cooling for home and commercial buildings and vehicles, application to solar energy conversion, aesthetically pleasing paints for home/commercial solar collectors.

N94-210 TITLE: Dynamic Simulation of High Power Machinery Systems

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Training Systems

OBJECTIVE: Develop a computer model of the dynamic behavior of shipboard high power electrical and mechanical machinery systems. This model will produce the instantaneous electrical waveforms using information gathered from a validated reduced order simulation model.

DESCRIPTION: To simulate and model shipboard mechanical and electrical systems (main propulsion, electric power generation, electric drive, or electric guns, for example), the Navy currently must develop costly and time consuming detailed digital models and then use them to parameterize the systems. From these detailed models, reduced-order models are developed; the reduced-order models run faster and system analysis time is reduced. However, the reduced order models can only cover a limited range of parameter variations before they become inaccurate. This SBIR topic looks for methods of producing detailed waveform outputs, like those that would be produced by a detailed digital simulation, from a reduced-order model. This capability will significantly improve the current design cycle (detailed model, to reduced-order model, back to detailed model). A model like this will enhance the capabilities of the Navy to integrate future weapon systems such as electrothermal-chemical guns, electromagnetic aircraft launchers, or high energy lasers into shipboard HM&E systems.

PHASE I: Devise a technique to obtain information from an accurate reduced-order simulation of a high power machinery system and reconstruct the instantaneous steady-state waveforms, including harmonics. Prove the feasibility of this technique to provide the waveforms without performing a detailed computer simulation.

PHASE II: Apply the developed technique to several high power machinery system configurations to validate equipment models within the system and instantaneous waveform reconstruction process.

PHASE III: Navy prime contractors should require technical support.

COMMERCIAL POTENTIAL: This research provides reduced cost simulation and an in-house capability for industry to study a wide range of high power machinery systems.

N94-211 TITLE: Recycling Ships' Plastic Waste

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Environmental Quality and Civil Engineering

OBJECTIVE: To obtain the knowledge and understanding of recycling ship-generated plastic wastes, develop suitable technology, and to demonstrate that technology using plastic from a Navy Plastic Processor.

DESCRIPTION: Navy ships generated 0.1-0.2 lb/man/day plastic waste and must retain this waste while at sea for disposal ashore. Most Navy ships will be equipped with Plastic Processors to densify ships' plastic waste for longterm storage. This waste, in densified form, will be returned to shore for disposal. Recycling technology is needed to avoid landfilling potentially valuable plastic, thereby avoiding disposal costs and to further federal recycling goals.

PHASE I: Investigate techniques applicable to contaminated, commingled plastic waste streams.

PHASE II: Demonstrate promising technology using Plastic Processor product.

PHASE III: Transition to the Navy's Advanced Development Program.

COMMERCIAL POTENTIAL: This technology has application in the private sector in the recycling of contaminated, commingled plastic wastes.

N94-212 TITLE: Low-Energy Non-Invasive Methods for Membrane Cleaning

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Environmental Quality

OBJECTIVE: Obtain the knowledge and understanding of the mechanisms that cause fouling of membranes in wastewater treatment processes to permit the application or invention of reliable continuous low energy non-invasive methods which will limit membrane fouling.

DESCRIPTION: The primary disadvantage to membrane separation processes is the inevitable and repeated fouling of the membrane surface and the subsequent decline in flux. Typically, the resolution to this problem is the regular use of enzymes, chemicals, or sponge balls to clean the membrane surface and recover flux. Frequent cleanings lead to significant problems associated with logistics, safety, and cost. A continuous low energy non-invasive method which maintained near initial membrane flux would decrease the size of a treatment system as a result of increased production per square foot of membrane surface area. This method would not involve the use of additives or mechanical devices.

PHASE I: Investigate the mechanisms of membrane fouling in wastewater applications. Investigate concepts and develop techniques to continually, and in a non-invasive manner, clean the membrane surface during processing.

PHASE II: Demonstration of a low energy non-invasive method(s) for membrane cleaning on a bench-scale membrane-based wastewater treatment process.

PHASE III: Transition to the Navy's Advanced Development Program.

COMMERCIAL POTENTIAL: This technology has application in the numerous installations using membrane separation in the wastewater treatment and chemical industries.

N94-213 TITLE: Radiation Curing of Pigmented Coatings

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Materials and Structures

OBJECTIVE: Development of radiation-cured coatings for Naval or civilian applications which provide anticorrosive protection, and can be applied and cured quickly to both minimally and properly prepared surfaces, including cold surfaces.

DESCRIPTION: A radiation-cured coating is required which will cure at 50 degrees F or lower, and provide a minimum of 3 years service. It should meet the stringent volatile organic compound (VOC) emission standards. In addition, all components should be packaged together so the mixture can be brushed on without requiring prior mixing.

PHASE I: During phase I, different formulations will be investigated: (1) to establish which chemical compositions perform best when subjected to tests which include salt fog (e.g., 500 hrs), impact tests, pencil hardness tests, tape adherence tests; and (2) to establish which surface treatments or formulations effectively increase adhesion.

PHASE II: In-service trials will be conducted, and licensing and commercial production requirements will be developed.

PHASE III: Completion of field trials and scale-up for production.

COMMERCIAL POTENTIAL: Radiation curable coatings have a large maritime and commercial potential because they generally cure in less than one minute, and have almost no volatile organic compound emission. They can be utilized in industrial plants, e.g., for machinery touch-up applications on non-interference basis, without requiring shutting the plant.

N94-214 TITLE: High-Current Switchgear

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Electron Devices

OBJECTIVE: The objective of this topic is to develop switches, flexible joints, and interconnection schemes for high current (50,000 to 200,000 Amp), low voltage (less than 1000 volts) a.c. or d.c. power distribution systems. In addition, for signature and safety reasons, stray electromagnetic fields must also be controlled.

DESCRIPTION: Electric Propulsion for ships will require distributing and controlling steady state electric currents on the order of 50,000 to 200,000 amps. At these levels, sizes and stiffness of distribution systems become significant. Buswork designs are required which can accommodate shock and vibration, and resultant relative motions of equipment. Current interruption devices which can handle steady state and fault currents must also be developed. In order to protect personnel and minimize the risk of ship detection, magnetic fields from those currents must be minimized. Additionally, in order to achieve design goals, switchgear, conductors, and connectors will need to be affordable and reliable.

PHASE I: Develop designs for high current switch(es), flexible joint(s) and connectors which minimize stray magnetic fields.

PHASE II: Construct and test prototype hardware for selected design(s).

PHASE III: Develop manufacturing processes for high current components.

COMMERCIAL POTENTIAL: Electric utilities are becoming increasingly concerned about the biological effects of electromagnetic fields. Techniques developed could be transitioned to electric utility applications, albeit at higher voltage and power levels.

NAVAL SURFACE WARFARE CENTER/DAHLGREN DIVISION/WHITE OAK DETACHMENT

N94-215 TITLE: Compact Integrated Electro-Optic Information Storage and Retrieval System

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Sensors

OBJECTIVE: To develop and demonstrate a fast, compact, rugged, low cost, very high density optical data storage and retrieval system.

DESCRIPTION: Photopolymer and photorefractive materials provide optical memories capable of storing the equivalent of terabits of data in 1 cubic centimeter volume. However, current mechanisms for randomly accessing this data are handicapped by high cost, bulkiness, and the requirement of precise optical alignment. An improved compact, high performance data storage/retrieval system consisting of a light source, an electro-optic phase/amplitude control device or material which is monolithically interfaced to memory is sought

PHASE I: Development, analysis and/or experiments to show proof of concept.

PHASE II: Develop and deliver a fully functioning prototype compact, integrated electro-optic data storage and retrieval system, including the drive electronics.

PHASE III: Further development in support of a designated Navy application.

COMMERCIAL POTENTIAL: Exists in high speed data storage for array processors, finger print analysis, medical diagnostics and documentation archiving/retrieval.

N94-216 TITLE: Radar Tracking Improvement in Multipath and Deception Environments

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Sensors

OBJECTIVE: Air defense tracking radar performance can be seriously degraded by multipath reflections and deception electronic countermeasures (ECM) including repeaters and decoys. The goal of this effort is to identify and evaluate software techniques that mitigate multipath effects. New techniques can be retrofitted into existing shipboard radars to enhance ship air defense.

DESCRIPTION: While tracking radars of all types are candidates for this effort, lock-follow and track-while-scan monopulse radars are of particular interest. In this effort multipath mitigation is of more interest than deception ECM mitigation. At a minimum, software approaches using complex indicated processing will be studied to generate tracking accuracies sufficient for fire control solutions. Obvious techniques, such as track filtering, or previously tested techniques, such as adaptive nulling, are of little interest. Generic, unclassified radar and ECM parameters will be analyzed in Phase I; specific, classified parameters and equipment will be used for Phases II and III, respectively.

PHASE I: The proposed mitigation techniques will be analyzed, via computer simulation to assess improvement in tracking radar performance. Test costs and data collection requirements will be defined in the final report.

PHASE II: Feasibility demonstrations of mitigation techniques will be performed by: (a) off-line processing of field test radar tracking data or (b) on-line processing of data from a government furnished tracking radar. Hardware modifications and software programs will be deliverables from the contractor. A final report, documenting test conditions and results, will be written.

PHASE III: Successful mitigation techniques will be transitioned to retrofit of existing radars.

COMMERCIAL POTENTIAL: Potential commercial and other government applications of the techniques exist such as FAA terminal approach radars.

N94-217 TITLE: Structured Essential Model for Mine Warfare

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Software

OBJECTIVE: Develop an abstract, systems-independent, low-level, detailed, structured essential model of Mine Warfare using for example, the established notation of Hatley/Pirbhai, the approach of Ward/Mellor, and/or the software tool -- Cadre Technologies, Inc.'s TeamWork.

DESCRIPTION: The model will be used to determine quantitative requirements for mine countermeasures (MCM) and for mining. These quantitative requirements can then be mapped to candidate solutions (architectures) for solving littoral warfighting scenarios, for the purpose of evaluating and selecting among them. In particular, the appropriate mix and emphasis of the real-time interaction of intelligence, C^4I, precision localization, and MCM equipments can be assessed independently of the present stake-holders.

PHASE I: The chosen contractor can draw upon government material to define requirements, deficiencies, research, technology, development, fleet systems, and existing their use in models. Model notation and consistency will be used to develop a high-level/low-level abstract model of Mine Warfare. From this completed model, provide a preliminary indication of recommendations for the appropriate mix and emphasis of the real-time interaction of intelligence, C^4I, precision localization, and MCM equipments. Select two initial promising architectures for detailed mapping in Phase II.

PHASE II: Using the two initial architectures recommended in Phase I, map the developed model to architectural models, using the Ward/Mellor or alternative approach. Evaluate each model quantitatively with respect to Structured Essential Model requirements.

PHASE III: Develop detailed designs for the best Mine Warfare architecture, using Ward/Mellor structure-chart design techniques.

COMMERCIAL POTENTIAL: This methodology can be used to demonstrate new potential markets for combining data bases of information with real-time communications and GPS systems.

NAVAL SURFACE WARFARE CENTER/DAHLGREN DIVISION/COASTAL SYSTEMS STATION

N94-218 TITLE: Quiet, Non-Magnetic Propulsion System for Small Expendable ROVs

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Surface/Subsurface Vehicles

OBJECTIVE: Develop a quiet, non-magnetic or very low magnetic propulsion system to power a small expendable remotely operated vehicle (ROV). This system should also have a low acoustic signature and should be low cost.

DESCRIPTION: The Navy is currently developing small expendable ROVs for use in mine countermeasures. These vehicles must be extremely quiet, acoustically and magnetically, to allow close approach to active sea mines without activating the mine.

PHASE I: Develop and design a non-magnetic, quiet propulsion system. This system should be capable of powering a thirty to fifty pound vehicle at approximately six knots, for a short time period (several minutes), in ten to eighty feet of water. This system's volume should be 175 cubic inches, or less. Specifications and Level I drawings should be developed. The propulsion system should be capable of redesign for larger vehicles if desired.

PHASE II: Fabricate and test the non-magnetic, quiet propulsion system designed in Phase I. These tests will verify that the propulsion system meets the requirements stated above.

PHASE III: Produce a non-magnetic, quiet propulsion system for use in the Navy's Instride Neutralization system development.

COMMERCIAL POTENTIAL: New propulsion system can be utilized by industry in applications requiring non-magnetic propulsion.

NAVAL UNDERSEA WARFARE CENTER/NEWPORT DIVISION

N94-219 TITLE: Integrated Digital Electronic Warfare (ESM) - Communications Receiver Technology

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Electronic Warfare

OBJECTIVE: To identify emerging digital radio receiver technology suitable for improving electronic warfare antenna subsystem performance, with the potential for integration of communications receiver functions.

DESCRIPTION: Electronic Warfare (ESM) antenna subsystems are subject to antenna size constraints aboard submarines. The search for ways to maintain or improve signal intercept performance, while reducing antenna size, continues. The Navy needs to fully exploit digital electronic receiver technology in establishing ESM antenna size tradeoffs. Similar tradeoffs exist in submarine communications. It is desirable to consider collocating antenna and receiver functions to jointly serve electronic warfare and communications requirements.

PHASE I: Analyze digital communications intercept techniques in conjunction with ESM antenna size tradeoffs. Identify opportunities to collocate communications receiver functions with communications intercept (ESM) functions as part of a communications antenna size tradeoff in UHF and SHF bands.

PHASE II: Develop high performance digital receiver(s) with direct application to ESM and communications functions. Demonstrate an improved digital intercept receiver with ESM and communications antennas at the Naval Undersea Warfare Center, New London.

PHASE III: Develop a prototype, dual purpose, integrated digital receiver that improves antenna subsystem performance for ESM and communications.

COMMERCIAL POTENTIAL: New equipment and methodology applicable to broadband commercial wireless communications.

SPACE AND NAVAL WARFARE SYSTEMS COMMAND

N94-220 TITLE: Standard Database User Interface

CATEGORY: Basic Research

SERVICE CRITICAL TECHNOLOGY AREA: Software

OBJECTIVE: To develop tools for visualizing and managing large and multi-media data bases using a standard GUI, making it easier for the operator to exploit ever larger information domains, independent of application or platform.

DESCRIPTION: Traditional database management technologies typically implement single, or terminal, end-user functions based on specific applications or user requirements and well defined data sets. Current database management tools, even if multi-user, implement front-end applications which are proprietary, and must be re-developed to run on top of other commercial database products. Thus the domain for data access and integration into useful, even creative, products, is still limited. As multi-media applications and databases evolve to include more data types, applications, and users, a need for a standard, open system interface to visualize and manage the data in the data base will become more and more important. It is clear that without such visualization and manipulation, the user's ability to exploit the information contained in a large multi-media data base in a timely manner will be greatly restricted and may be limited to single applications. In addition, the flexibility required to add new data management processes, such as object data management, will be limited.

PHASE I: Complete a 6 month study to identify a standard visualization/ manipulation technique suitable for large multi-media data bases which support 1D, 2D, 3D, and continuous (4D) representations. Demonstrate this on a single computer platform using a UNIX environment and a specific data type.

PHASE II: Develop and implement improvements and enhancements to the data visualization/manipulation techniques to encompass a broad range of data types with a large data volume. Demonstrate this capability on a network, across different operating systems and commercial database engines.

PHASE III: Transition this technology to a high-end government owned workstation which runs on a government owned network and has access to a large data volume.

COMMERCIAL POTENTIAL: This technology could be applied over a broad range of commercial, medical, and industrial users.

N94-221 TITLE: Controllable Take-Off Angle High Frequency Antennas

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY: Communications

OBJECTIVE: Develop a high frequency (2-30 Mhz) antenna that will enable control of the take-off angle independent of frequency and antenna height.

DESCRIPTION: The Navy currently uses three types of high frequency transmitting antennas: vertical monopoles, horizontal monopoles, and wire fan antennas that excite the ships' structure. All these antennas exhibit variations in take-off angle resulting from the mounting position above the effective ground plane and the frequency in use. This results in changes in communications range as the frequency or antenna selected is varied. Given the requirement to maintain point-to-point communications, it is desirable to develop an antenna that will maintain a constant or controllable take-off angle throughout the high frequency spectrum. Take-off angles of interest range from low(near the horizon) for long haul propagation to high (near-vertical ionospheric incidence) for short range circuits.

PHASE I: Develop the basics of antenna characteristics and their interaction with shipboard structures. Determine characteristics of existing antenna designs that determine take-off angles, and performance penalties which are related to the requirement to control take-off angle.

PHASE II: Develop, test, and demonstrate an antenna or antennas that feature a controllable take-off angle or a take-off angle independent of frequency. The antenna(s) will be suitable for shipboard installation for test purposes. The antenna(s) shall operate across the high frequency band with a VSWR of less than 4:1, and have an omni-directional pattern in the horizontal plane and accept an input power of at least one kilowatt, preferably four kilowatts.

PHASE III: Produce an antenna for shipboard use that meets all the above criteria and is qualified for shipboard installation.

COMMERCIAL POTENTIAL: This antenna will enhance any high frequency point-to-point communications circuit by alleviating the need to consider take-off angle when adjusting operating frequency for ionospheric changes.

N94-222 TITLE: Automated Detection and Identification of Materials in Hyperspectral Images

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Software/Sensor

OBJECTIVE: Develop a robust technique for automatic detection and identification of target materials in hyperspectral images.

DESCRIPTION: Several techniques for detection and identification of materials in multi/hyperspectral images have been used from various types of statistical classifiers to correlation/matched filter based approaches. The statistically based classifiers are limited since they do not account for the prevalent case of mixed pixels which are pixels that contain multiple spectral classes. Existing correlation/matched filter based approaches suffer from the mixed pixel problem as well as the limitation that the output of the matched filter is non-zero and quite often large for multiple classes since the spectral signatures of materials are not orthogonal vectors. This effort is directed toward development and implementation of an improved technique that has the following characteristics:
1) Both pure and subpixel cases are addressed (e.g., each pixel can belong to multiple classes); 2) Prior knowledge of background material spectral signatures is not required;
3) The technique performs well at low Signal-to-Noise Ratios (SNRs) (e.g., 25:1 referenced to 50% reflectance); and
4) The technique has a mathematically rigorous description, and its performance as a function of SNR and other relevant parameters can be evaluated quantitatively.

PHASE I: Conduct a 6 month study to develop the theory and simulate the detection and identification technique. A theoretical performance/sensitivity analysis will be performed. Both simulated and real imaging spectrometer data sets will be processed to verify the performance of the technique.

PHASE II: After prototyping the technique will be implemented in a Government owned spectral processing workstation.

PHASE III: Demonstrate use of this technique in conjunction with existing Navy hyperspectral sensors is anticipated.

COMMERCIAL POTENTIAL: The technology has application to several problems such as agricultural monitoring, pollution control and environmental assessment.

N94-223 TITLE: Demand Assigned Multiple Access (DAMA) Network Manager

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Command, Control, Communication

OBJECTIVE: Design, develop and demonstrate an super high frequency (SHF) DAMA network controller that will optimize SHF DAMA access utilization by allowing rapid network-wide re-configurations of circuit parameters. The controller shall permit the rapid design and automatic implementation of tailored SHF Satellite Communications (SATCOM) connection plans by fleet communicators.

DESCRIPTION: The Demand Assigned Multiple Access (DAMA) modems currently being procured for Navy SHF SATCOM are capable of limited remote control. An SHF DAMA network controller is needed to simplify the operation of these modems as a network. The controller software should be developed in a windowing environment and facilitate the integration of current PC-based modem control software. The controller shall also provide a standard interface for control signaling exchange with the Copernicus Tactical Data Information Exchange Subsystem (TADIXS) Network Manager.

PHASE I: Define the operational requirements for the SHF DAMA Network controller. Develop a Software Requirements Specification (SRS) for the controller.

PHASE II: Develop and demonstrate a prototype SHF DAMA Network Controller system.

PHASE III: The SHF DAMA network controller can be used as a basis for development of commercial Ka and Ku band network controllers.

COMMERCIAL POTENTIAL: The Copernicus TADIXS architecture specifies the use of either the defacto standard Simple Network Management Protocol (SNMP) or the International Standardization Organization (ISO) Common Management Information Protocol (CMIP) for the Network Manager control signaling interface. The use of open system standards and commercial products in the Network Manager make it directly applicable not only to commercial satellite communications systems but to most commercial telecommunications systems. state-of-the-art telecommunications equipment provides a standard Control and Management interface which complies with SNMP. New products with CMIP interfaces are appearing on the market as industry begins to adopt the ISO standard.

N94-224 TITLE: GPS Anti-Jam Antenna

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Command, Control, Communication

OBJECTIVE: Develop a GPS antenna with beam steering, and adaptive nulling features to aid GPS initial acquisition and track phases.

DESCRIPTION: GPS receivers used by the military and civilian communities may be forced to track and/or to perform an initial acquisition of GPS satellites in the presence of jamming. GPS anti-jam antennas with high gains and narrow beamwidths can be steered toward GPS satellites while creating nulls in other directions. This will increase the received satellite power levels while significantly attenuating any unwanted incident jammer power levels to ensure successful GPS initial acquisition, and subsequent GPS track. The proposed GPS anti-jam antenna should not be larger than the present Fixed Reception Pattern Antenna (FRPA) currently used by Navy aircraft. The GPS anti-jam antenna shall be capable of steering toward four or more GPS satellites (sequentially or in some other optimal fashion) at a rate that will provide sufficient navigation fixes to meet the performance requirements of high dynamic fighter type aircraft.

PHASE I: Conduct a six month study to determine existing literature and software on adaptive null-forming and beam steering antennas. Determine potential requirements for external aiding systems such as Attitude and Heading Reference Systems (AHRS) or Inertial Navigation Systems (INS) which could provide azimuth and elevation steering commands. Analyze use of current almanac, ephemeris, and time from one satellite in assisting in the acquisition and track of other satellites. Prepare preliminary report on findings.

PHASE II: Develop detailed designs and build a prototype of the GPS antenna.

PHASE III: Demonstrate the prototype system under operational conditions. Produce a report and briefing containing test results.

COMMERCIAL POTENTIAL: Airlines, ships, and all potential GPS users.

N94-225 TITLE: Shallow-Water Surveillance Data Fusion

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Software

OBJECTIVE: Develop innovative signal processing algorithms to demonstrate the feasibility of data fusion and situation display in support of Joint Surveillance missions in shallow water for target detection (submarines, mine laying, surface ships, and swimmers) at reduced cost.

DESCRIPTION: Joint surveillance requirements exist to fuse disparate data from multiple sources, of differing resolution, timeliness, and confidence into a combined assessment of regional shallow water environments. A robust shallow water surveillance capability is important to ensure the Navy's success against targets in future regional conflicts. Accomplishment of this synthesis dictates evaluation and integration of theater, force organic, national and non-traditional sensor data. The situation display of the product must go beyond traditional contact, track, track projection, warfare area and current mission manipulation and displays. The ability to cue other collection assets under dynamic conditions and providing relevant displays is of primary concern. Proposals should offer specific algorithmic chains.

PHASE I: Conduct an analysis to determine approach for integrated algorithms and display concepts for joint surveillance situation assessment and dynamic sensor management. This analysis will include the effects of specific shallow water problems (reverberation, multipath, bottom slope, interfering noise, water clarity,etc.). Prepare an algorithmic specification and provide a technical report.

PHASE II: Design, develop and demonstrate an integrated multisensor data fusion and situation display system using existing or new algorithms/code, as appropriate. Demonstration will be conducted in a realistic environment and require an innovative concept for demonstrating the system. The Navy will support the contractor's demonstration efforts. Provide a detailed technical and test report. Update algorithmic chain and display format specifications.

PHASE III: Transition is to the Surveillance Direction System.

COMMERCIAL POTENTIAL: Law Enforcement (drug interdiction and illegal fishing vessel management). Oceanographic Research (whale and fish tracking).

N94-226 TITLE: Neural Net Temporal Pattern Signal Recognition and Classification

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Software

OBJECTIVE: Develop neural network techniques for detecting and recognizing weak, temporal signals of interest (SOIs) and signals not of interest (SNOIs) in the presence of interference and non-Gaussian noise.

DESCRIPTION: Neural network research has been active for some time. Its application to signal processing has many potential benefits, among them signal identification, filtering, adaptive detection, and search. Significant experience has been gained in the field of static pattern recognition, and neural nets have been particularly successful in that domain. Applying them to the difficult problem of reliably detecting and recognizing weak, temporally varying signals, however, remains a challenge, but shows promise. This effort attempts to develop new techniques to detect and recognize conventional signal types within a dense, dynamically changing, interference environment.

PHASE I: Conduct a 6 month effort to develop and validate potentially useful neural net techniques as applied to detecting and recognizing weak, temporal signals in the presence of interference. The study will involve validating the technique against a simulated environment containing a combination of signal types at varying levels of interference.

PHASE II: Develop and implement the technique in a signal processing workstation environment. Apply the technique against real data sets containing dense emitter environments.

PHASE III: Transition the technique to a government owned signal analysis workstation.

COMMERCIAL POTENTIAL: Cellular telephone industry.

N94-227 TITLE: Improved VHF Antenna System

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Command, Control, Communication

OBJECTIVE: Develop a hybrid VHF antenna capable of simultaneous reception of the Automatic Picture Transmission (APT) signal and the TIROS Information Package (TIP) data stream from the NOAA TIROS satellite.

DESCRIPTION: Two critical remote sensing data streams available from the NOAA TIROS satellite are currently received on separate U.S. Navy satellite receiver systems, despite the two data streams being transmitted on nearly coincident VHF carrier frequencies. The medium resolution APT satellite atmospheric imagery, transmitted at 137.50 and 137.62 Mhz, is received by the main antenna of the Mobile Oceanographic Support System (MOSS). The TIP data stream, containing "ARGOS" transmitter data, is transmitted at 136.77 and 137.77 Mhz, and is receivable only by the antenna system of the FG-7104 Local User Terminal (LUT), both operated by the Naval Oceanography Command. A hybrid antenna capable of simultaneously receiving both the APT and TIP signals would allow both signals to be received and displayed on the MOSS.

PHASE I: Assess possible designs which assure sufficient noise filtering and signal pre-amplification; perform trade-off studies.

PHASE II: Develop and build prototype antenna; test ashore on MOSS equipment to troubleshoot and finalize design; test prototype at sea to simultaneously receive both the APT and TIP signals in various weather conditions.

PHASE III: Anticipate Navy and possible other DOD sponsorship to upgrade current systems.

COMMERCIAL POTENTIAL: The hybrid antenna, working in conjunction with a dual-use VHF receiver circuit card constructed to fit in the expansion slot of a DOS- or UNIX-based notebook computer would provide a unique combination of easily received atmospheric imagery and "ARGOS" transmitter data. No such system is available today, commercial or otherwise.

N94-228 TITLE: Navigation Systems for Drifting Buoys, Autonomous Vehicles and Underwater Platforms

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Command, Control, Communication

OBJECTIVE: Development of accurate, durable, low power, non-magnetic navigation systems to determine position and heading for use in drifting buoys, small autonomous underwater vehicles and other underwater platforms.

DESCRIPTION: Existing navigation systems used in sonobuoys, drifting buoys and other autonomous platforms are inadequate. For example, magnetic compass engines develop long term drift, can be affected by metal objects and lack the directional accuracy required for determination of heading for some applications. In addition, all U.S. Navy drifting buoys that use the Data Collection System (DCS) of the NOAA TIROS satellite ("ARGOS" system) rely on satellite-measured doppler shift data to determine buoy position. The process of using doppler shift calculations for position fixing uses complex orbital model algorithms initialized by an extensive and costly network of fixed "ARGOS" reference transmitters. Organic navigation systems (e.g., combinations of electronics such as GPS receivers, optical compasses, etc.) could vastly improve position fixing/heading. Such systems would necessarily require low power and cost, and be extremely compact in size and weight.

PHASE I: Technology assessment of the state of the art of compass/navigation systems for small, light, low powered applications. A summary report and conceptual design/approach will be delivered.

PHASE II: Develop, test, and evaluate a prototype navigation system for use on expendable drifting buoys/autonomous vehicles and swimmer navigation systems.

PHASE III: Pending successful completion of Phase II, an Engineering Development program (6.4) will be pursued. Transition to operational use is anticipated.

COMMERCIAL POTENTIAL: A non-magnetic navigation system has a wide variety of commercial applications.

N94-229 TITLE: Increased Antenna Bandwidth at High Frequency HF and Ultra High Frequency UHF Applications

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Command, Control, Communication

OBJECTIVE: Develop a broadband antenna design approach using Genetic Optimization Algorithm.

DESCRIPTION: The Navy currently uses trial and error techniques in providing the parameters for component selection to achieve a level of acceptable gain and impedance performance for Shipboard topside antennas.

PHASE I: Design a broadband HF antenna using the Genetic optimization algorithm. The algorithm is to be applied to the design of various low-pass and high-pass band filters operating between practical terminal conditions. The design would take into account both the antenna loading and the matching network thus achieving optimal gain and impedance performance.

PHASE II: Utilizing the Genetic Optimization Algorithm develop, test, and demonstrate a 2-30 Mhz broadband antenna. The antenna shall be operable within 2-30 Mhz and be practical for installation in a shipboard topside environment with matching network no greater in size than currently used for shipboard. Single whip dipole antennas. The antenna will have minimal EMI/EMC characteristics and an optimal power efficiency that is superior to that of the present design.

PHASE III: Produce antennas that utilize the Genetic algorithm or Produce software for use by antenna manufacturers to use in production of Navy HF and UHF antennas.

COMMERCIAL POTENTIAL: New Genetic Algorithm would be used by all antenna manufacturing requirements that have broadband commercial applications.

N94-230 TITLE: Distributed Feedback Laser for Fiber Optic Multiplexing

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Electron Devices/Sensors

OBJECTIVE: Develop and fabricate pressure and temperature tolerant pigtailed distributed feedback laser for wave length division multiplexing in fiber optic data links. The lasers must be capable of being fabricated to operate at specified pre-selected wavelengths in the region from 1.52 to 1.56 microns.

DESCRIPTION: The capability of undersea fiber optics system can be significantly enhanced through the use of wavelength division multiplexing. For long haul links the preferred operating wavelength region is near 1.55 microns, where fiber loss is a minimum and erbium amplifiers can be used. The use of an erbium optical amplifier coupled with this laser development could boost the power to approximately 17 dBm. The design goals are: stable output power in excess of 1 milliwatt, wavelength variation of less than 1 nanometer, small package design (maximum dimensions 1 mm X 12 mm X 30 mm), and consistent performance at pressures between 0 to 10,000 pounds per square inch (psia) and temperature from 0 to 40 degrees Celsius without active cooling.

PHASE I: Design a distributed feedback laser (or design a coupled laser/amplifier) fabrication process which allows for an emission wavelength that can be selected in the range from 1.52 to 1.56 microns. Design a single mode fiber pigtailed laser package that enables laser operation over wide pressure and temperature ranges without the use of thermoelectric coolers.

PHASE II: Fabrication of several lasers with pre-determined emission wavelengths in the 1.52 to 1.56 micron region with a precision of 2 nanometers should accomplished. Typical wavelength difference for the fabricated laser will be between 10 and 20 nanometers. The lasers should be tested with respect output power and spectral characteristics over a pressure range from 0 to 10,000 psia, and over a temperature range from 0 40 degrees Celsius.

PHASE III: Laser transmitters should be fabricated for a demonstration of a three channel multiplexed data link system. The emission wavelengths will be specified values in the 1.55 micron region. Specification capabilities of the multiplexed data link system will be provided to the All Optical Deployed Sensors prime contractor as an enhanced component/device for potential technology insertion into Advanced Distributed Systems (ADS).

COMMERCIAL POTENTIAL: Increased data capacity for undersea and land telecommunication systems per fiber by a factor of five to ten.

NAVAL COMMAND, CONTROL & OCEAN SURVEILLANCE CENTER/RDT&E DIVISION

N94-231 TITLE: A Technique to Integrate Independently Developed Decision Aid Models

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Software

OBJECTIVE: Initially, explore the development effort to integrate disparate decision aids and demonstrate the problems. Develop working a version and then a suitable product for insertion in a major military decision support system. Show how dissimilar algorithms can contribute a greater decision capability when integrated (by this technique) into a cognitive tactical paradigm.

DESCRIPTION: This topic seeks the solution of the problem of integrating disparate processes, models and algorithms without re-writing the software. There are stand-alone Tactical Decision Aids which contribute partial solutions that are subsets of larger, more comprehensive problems and must be integrated manually by the decision-maker, into the context of his more encompassing decision process. There is no process for integrating independently developed decision aids into a single interactive, on screen display process. For instance, target managers will be aided in their decisions if the interaction of various existing target tracking algorithms can be compared and interleaved. This effort would apply the results of academic research in Model Management Systems, to an exploratory demonstration of target tracker integration.

PHASE I: Develop a JOINT Surveillance Architectural Overview for the 1998-2003 time-frame. Bound the requirements for sensor assets and fusion with a Power Projection scenario, hypothesizing three possible integrated surveillance systems. Develop a prototype mock-up of the Model Management System technology using trackers that support the integration of surveillance information from Theater, Organic, and Non-traditional sources.

PHASE II: Create a working version of a Model Management System applying tracker algorithms in the Joint Surveillance Architecture. The successful completion of Phase II of this program will provide a stand-alone (i.e. dedicated host) Model Management System that integrates independent tactical decision aids and which can be he-hosted into Unified Build (UB) as an operating system utility.

PHASE III: Develop a Model Management System, available as an upgrade to the UB. Such an upgrade would be an integration mechanism that would allow the individual Optional Application Tapes (i.e. the models) to interact under an operator's control. This would be major breakthrough in interactive decision support technology and would be applicable to several joint surveillance programs such as the Maritime Surveillance Anchor Desk and the Advanced Deployable Surveillance with Surveillance Direction System, also command and control concept programs such as Croesus and T/R/S.

COMMERCIAL POTENTIAL: This technology will be directly applicable to integrating the operations analysis models of the Management Science discipline. Existing models such as those of Utility Theory, Product Mix, Blending, Transportation, Queuing, Game Theory, and Inventory can be directly integrated by the technology of Phase II. This success would offer the first interactive decision support tool that bridges the gap among the disparate management domains of a corporation, a very real commercial benefit.

N94-232 TITLE: Microelectronic Packaging Using Diamond Film Heat Spreaders

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Electron Devices

OBJECTIVE: Investigate suitable combinations of microelectronic packaging materials to use with diamond film heat spreaders for optimal package performance.

DESCRIPTION: Diamond film is a new technology finding application in dissipating heat in high power microelectronic packages where thermal problems exist using current thermal management methods. The properties of diamond film make it well suited for this application, especially in military high power electronic packages. However, there are several concerns with this technology that warrant further research. First, the use of this material in combination with existing microelectronic packaging material has not been well investigated. Second, initial use of diamond film as a heat spreader in microelectronic packages has indicated that problems exist in the intermetallic bonding of diamond film to surfaces. Third, the appropriate placement of diamond film within the package for best thermal performance has not been investigated.

PHASE I: Investigate and test suitable materials to use with diamond film heat spreaders. Materials must be commonly used within microelectronic packages. Develop methods for integrating diamond film with current high power microelectronic packaging techniques.

PHASE II: Develop prototype high power microelectronic packages that use diamond film heat spreaders in conjunction with the materials identified in Phase I. The prototype packages must show optimal performance when compared to similar packages that use current materials and thermal management technology. In addition, moderate to high volume manufacture of the packages should be addressed.

PHASE III: Integrate Phase II developments into the design and manufacture of high power microelectronic package for Navy systems.

COMMERCIAL POTENTIAL: High power microelectronic packages are used in commercial communications systems; satellites, avionics, and other industrial and consumer products.

N94-233 TITLE: Encyclopedic Browsing

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Human System Interface

OBJECTIVE: Develop a domain-independent indexing scheme which would allow rapid and flexible encyclopedic access to large multi-domain knowledge bases.

DESCRIPTION: Current indexing schemes are inadequate for true encyclopedic browsing. They require that all possible uses of the indices and of the information being retrieved be anticipated prior to structuring the index system. In addition, they impose an artificial rigidity on the search process. Given that machine knowledge bases will continue to increase in size and complexity, that requirements to search large knowledge bases will expand, and that tactical decisions made under stressful conditions require rapid access to information, a system that provides rapid and flexible access to large multi-domain knowledge bases is necessary. In such a system an index is extracted or derived from the content of the object being indexed and used to determine whether the object is likely to be applicable in a given situation.

PHASE I: Develop the basics of a human system interface (HSI) which provides domain-independent context-sensitive encyclopedic browsing capability. The HSI must provide access to a large multi-domain knowledge base.

PHASE II: Develop, test, and operationally demonstrate an encyclopedic browsing HSI capability.

PHASE III: Produce an encyclopedic browsing HSI which implements the methods demonstrated in the Phase II SBIR effort.

COMMERCIAL POTENTIAL: A new methodology for an encyclopedic browsing HSI will be useful in any context where large knowledge bases must be accessed, e.g., medical diagnostic and support systems, business and economic systems, science and technology systems.

NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER

N94-234 TITLE: Measuring the Effect of Drawdown Programs on Personnel Retention

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Personnel and Manpower

OBJECTIVE: To develop a methodology to measure the marginal impact of drawdown policies on retention behavior

DESCRIPTION: Drawdown policies have had both direct and indirect effects on the retention of officer and enlisted personnel. however, it is difficult to disentangle these effects from normal voluntary behavior. This research would develop a methodology for identifying impacts and making adjustments to retention and continuation data.

PHASE I: Develop a theoretical model to statistically isolate the retention effects of drawdown policies including VSI/SSB, SER, HYT, 15-year retirement, and others.

PHASE II: Using actual data on personnel retention during FY92-93 estimate the model.

PHASE III: Take the results from Phase II and apply adjustments to existing retention data from FY92-93. Also, using the same methodology, estimate future adjustments for FY94-97.

COMMERCIAL POTENTIAL: Methodology can be used by other services to make adjustments to attrition, retention and continuation data, to obtain estimates of "normal" rates.

N94-235 TITLE: Configuring the Total Navy Workforce under Alternative Strategic Scenarios

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Personnel and Manpower

OBJECTIVE: Develop new measurement and configuration methods to increase accuracy and response of force sizing models.

DESCRIPTION: With a large decrease in force levels, the size of the Navy's support structure is expected to receive disproportionate "downsizing" pressure. With a workforce of almost 800,000 military and civilian personnel, even small errors in estimating the effects of changes in force levels have large workforce consequences. Typically, "rules-of-thumb" are used to make these estimates. Improvements in both model specification and measurement would increase capability.

PHASE I: Develop new workforce estimating relationships to reduce the number of fixed ratios used in forecasting the effects of alternative force levels. Model will embed total workforce, including proximate and second order effects and include both civilian and military components.

PHASE II: Develop, test and operationally demonstrate model which implements the methods formulated under the Phase I SBIR effort. The evaluation will employ mean absolute percentage error measures as well as "cost-of-error" measures.

PHASE III: Government-sponsored, non-SBIR, follow-on R&D, as required.

COMMERCIAL POTENTIAL: Workforce management in the commercial sector can benefit from more humane and effective methods for "rightsizing" afforded by this technology.

N94-236 TITLE: Models of Test Compromise

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Personnel and Manpower

OBJECTIVE: To develop a procedure for decrementing the aptitude test scores of those examinees that compromise test items.

DESCRIPTION: Model-based measures have been developed to classify examinees into those who have compromised one or more test items versus those who have not compromised test items. Although this information could be used to reprimand or punish applicants that appear to have cheated, operationally this could be problematic. Any detection procedure is less than perfect, and strong administration action based on a fallible measure could be undesirable from a public relations standpoint. A preferable approach would be to incorporate a decrement into the scoring procedure which, in effect, lowers the scores of those examinees that have response patterns similar to cheaters.

PHASE I: Develop item response models of test compromise. These models should incorporate the rate of item exposure (frequency of test item usage). Items with frequent usage are more likely to be compromised.

PHASE II: Develop estimation procedures for specifying the proportion of examinees that cheat on one item, two items, three items, and so forth.

PHASE III: Use the models developed in Phases I and II to specify a posterior distribution of ability given the observed response pattern. This posterior distribution should be computed from the response models for both normal and cheating applicants.

COMMERCIAL POTENTIAL: This procedure will have important use for standardized measures of aptitudes and abilities. This procedure could be used by commercial test publishers.

N94-237 TITLE: A System for Designing Random Access Instruction for Navy Courses

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Training Systems

OBJECTIVE: Determine the feasibility of developing an instructional design system based on Cognitive Flexibility Theory.

DESCRIPTION: Cognitive Flexibility Theory stresses that advanced knowledge acquisition is not only complex but also non-linear. Learners' goals must shift from familiarity and memorization to mastery of concepts and applications. The learner must adapt to radical changes in situational demands. While Navy instructional design has traditionally relied heavily on linear media such as textbooks, manuals and lectures, such media are most suited to material which is well-structured and relatively simple. The most effective delivery systems for developing cognitive flexibility in trainees require capabilities for random (rather than sequential) access. Technologies such as hypermedia and videodiscs permit non-linear, multidimensional instruction. Since complex content is often situation specific, situational complexities must be taken into consideration. In ill-structured domains, inter-case variability is too large for instruction based on abstracted conceptual knowledge. Thus, a case-centered approach is needed.

PHASE I: Examine critical elements of Navy training for complex content domains, and determine the applicability of Cognitive Flexibility Theory for designing random access instruction. The approach should be sufficiently generic to be applicable to several areas of advanced instruction.

PHASE II: Develop guidelines for a prototype system which delivers nonlinear, random access instruction in an important or critical Navy training area.

PHASE III: Develop and evaluate instruction based on these guidelines.

COMMERCIAL POTENTIAL: Primary marketing potential is in public education and increased training effectiveness for complex instruction in advanced concepts.

NAVAL MEDICAL RESEARCH & DEVELOPMENT COMMAND

N94-238 TITLE: Tactile Transducer Design/Development

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Medical

OBJECTIVE: To design and develop a tactile transducer for vibratory stimulation of the skin.

DESCRIPTION: The use of the vibrotactile sensory system for information transfer is the subject of many perception/cognition studies, specifically, the use of a tactile interface to improve situational awareness in the aviation and diving communities. However, even in the controlled atmosphere of the laboratory, the transducers available for Often, loading by the skin and surrounding tissue provide significant damping resulting in a reduction in stimulation amplitude. A device must be designed that is small, lightweight and capable of producing a vibratory stimulus above the sensory/recognition threshold. Several means for providing the efficient transfer of energy from the transducer into kinetic energy or vibratory movement of the skin and surrounding tissue have been proposed including:

1. Piezoceramic;
2. Electromagnetic;
3. Pneumatic; and
4. Direct Electrical Stimulation.

PHASE I: Provide detailed design drawings of the components and a prototype unit capable of safely producing an adequate stimulus at low energy consumption.

PHASE II: First six months, refine and test prototype unit for proof of design. Finally, optimize the transducer unit to include manufacturability and reliability considerations.

PHASE III: Produce a marketable tactile transducer that implements the attributes demonstrated during the Phase II SBIR effort for commercial applications.

COMMERCIAL POTENTIAL: The hearing and visually impaired, commercial aviation and diving communities as well as virtual reality applications are envisioned as beneficiaries of this development effort.

N94-239 TITLE: Radiolucent Shrapnel Locator

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Medical/Sensor

OBJECTIVE: Develop a detection and location device for shrapnel that is undetectable with standard x-ray equipment and imaging techniques.

DESCRIPTION: Shrapnel can produce serious injuries that may not become apparent until hours or days later. However, in many cases, the patient may be at greater risk from the trauma of attempted localization and removal than from the complications of retained shrapnel. Therefore, patient care is optimized when the size and location of shrapnel is determined prior to undertaking exploratory surgery for its removal.

PHASE I: Develop all the design specifications and circuitry to construct a non-invasive device that detects, locates, and ideally images rigid, radiolucent shrapnel (e.g. plastic, wood, unleaded glass) anywhere inside an intact human. The technology selected and its application must be capable of satisfying FDA approval criteria for medical devices, and be portable for use in military field hospitals.

PHASE II: Using the design specifications and circuitry developed during the Phase I SBIR, fabricate, test, and operationally demonstrate a prototype device that detects, locates, and ideally images rigid, radiolucent shrapnel (e.g. plastic, wood, unleaded glass) anywhere inside an intact human.

PHASE III: Produce a radiolucent shrapnel detector derived from the prototype Phase II SBIR device.

COMMERCIAL POTENTIAL: High; urban violence, industrial accidents, and motor vehicle accidents commonly produce imbedded radiolucent foreign bodies.

N94-240 TITLE: Combat Swimmer Underwater Decompression Computer for Air and Nitrogen Oxygen Diving

CATEGORY: Advanced Development

SERVICE CRITICAL TECHNOLOGY AREA: Medical/Computer

OBJECTIVE: Develop a small diver carried decompression computer capable of fully implementing the NMRI Air/ Nitrogen Oxygen Probabilistic Decompression Model in real time and which will record, store and download dive profile information.

DESCRIPTION: The Naval Medical Research Institute (NMRI) has developed a probabilistic decompression model (the NMRI Decompression Model) which will form the basis of the new USN Air and Nitrogen-Oxygen Decompression Tables. NMRI has also developed a real time implementation of the decompression model (the NMRI Real Time Algorithm) which runs on 486 personal computers. Diver carried hardware is needed which will implement this algorithm in real time. Hardware must meet criteria specific to the combat swimmer mission (acoustic and magnetic signature) and be rugged enough to withstand the rigors of real life missions. The NMRI algorithm is computationally intensive and may necessitate custom chips designs.

PHASE I: Develop all design specifications and circuitry including a microprocessor capable of fully implementing the NMRI Decompression Model in real time. NMRI will provide the decompression model in a format capable of running in real time on a 486 personal computer and will provide technical support to ensure that hardware model implementations are performing calculations correctly. Specifications must developed in close cooperation with the Navy combat swimmer community to ensure all relevant needs are met and they must approve the final set of specifications. The Navy will provide access to any in house technical expertise necessary to provide information needed to develop specifications. The hardware must be self contained, small enough to be worn on the forearm, and have sufficient internal power to remain active 24 hours and must display information in a format readily usable by the diver. It must operate down to a depth of 300 fsw. It must be usable at night without detection and be rugged enough to remain operational under severe combat swimmer mission conditions. It must be able to switch between specified breathing gases and must accurately record dive profile information. It must have an external interface for downloading stored information into a personal computer, for performing diagnostics, and for providing real time output of all displayed information to a personal computer. The entire device must be capable of having all aspects of its operation verified at the dive locker level and the pressure transducer must be able to be pressurized from a compressed gas source through a loader without the need of a pressure chamber. All software developed must be compatible with DOS based systems.

PHASE II: Using the design specifications and circuitry developed during Phase I, fabricate and test, and operationally demonstrate a prototype device that fully implements the NMRI Decompression Model and which will compute and display decompression information during operational dives. After prototype testing construct 50 units for field testing. Field testing should begin within the first 14 months of the start of Phase II. At the end of field testing (6 months) update the design specifications based on user input and produce 10 units suitable as pre-production prototypes including all supporting documentation and drawings. Also produce hardware and supporting documentation for retrieving, storing and archiving dive profile information and for performing user level maintenance and diagnostic procedures.

PHASE III: Pursue full scale commercial production of units in sufficient numbers to meet Navy needs.

COMMERCIAL POTENTIAL: High; commercial divers and sport divers utilize real time decompression procedures. Development of low power microprocessors capable of implementing complex and computationally intensive algorithms are useful for any small portable device which must implement these types of algorithms.

N94-241 TITLE: Enhancement of Protective Immunity against Malaria by Targeting DNA Immunization

CATEGORY: Exploratory Development

SERVICE CENTRAL TECHNOLOGY AREA: Medical

OBJECTIVE: Develop improved methods of plasmid DNA immunization by targeting antibody and specific T cell responses, and by targeting responses to specific organs.

DESCRIPTION: The Malaria Program, Naval Medical Research Institute has shown that immunization with plasmid DNA containing the *Plasmodium yoelii* circumsporozoite protein (PyCSP) induces high levels of antibodies and cytotoxic T lymphocytes against the PyCSP and moderative protection against challenge with infectious parasites. Focusing the immune response on specific antibody or T cell responses, or by targeting the effector antibodies or T cells to specific organs, especially the liver could have a major effect on increasing protective immunity.

PHASE I: Develop methods of constructing DNA plasmids that target antibody or specific T cell subset responses against defined epitopes. Develop methods of targeting immune responses to infected hepatoctyes, perhaps by constructing DNA plasmids that induce immunity within the liver.

PHASE II: Test these DNA plasmids in small laboratory animals and non-human primates alone and in combination for their capacity to protect against challenge with *P. yoelii* and *P. falciparum* respectively. Establish the safety of these plasmids in laboratory animals.

PHASE III: Produce cGMP material and assess it for safety, immunogenicity, and protective efficacy in human volunteers.

COMMERCIAL POTENTIAL: Development of such a method of immunization would revolutionize not only malaria vaccine development, but also the entire field of vaccinology, and thus would have enormous commercial potential.

N94-242 TITLE: Virtual Environment Training for Trauma Management

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Training Systems/Medical

OBJECTIVE: Develop a virtual environment device that will enable the initial and refresher training of medical personnel in the care of combat casualties.

DESCRIPTION: A high fidelity virtual environment device that contains hardware and software to simulate a variety of combat casualty patient care scenarios requiring proficient kinesthetic or eye-hand coordination. The device will simulate procedures that require using large mammals or actual patients for optimal training, such as the establishment of a surgical airway, needle thoracentesis for relief of tension pneumothorax, diagnostic paracentesis, and reduction of extremity fractures and dislocations.

PHASE I: Develop all the design specifications and circuitry to construct a prototype device described immediately above.

PHASE II: Using the products of the Phase I SBIR, fabricate, test, and operationally demonstrate a prototype high fidelity virtual environment device that simulates a variety of combat casualty patient care scenarios requiring proficient kinesthetic or eye-hand coordination.

PHASE III: Produce a high fidelity virtual environment combat casualty care trainer derived from the prototype Phase II SBIR device.

COMMERCIAL POTENTIAL: High; urban violence, industrial accidents, and motor vehicle accidents commonly produce serious trauma.

NAVAL FACILITIES ENGINEERING SERVICES CENTER

N94-243 TITLE: Monitoring Contaminant Releases in High Permeability Materials

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Environmental Quality and Civil Engineering

OBJECTIVE: Develop a technique to quantitatively monitor release of low volatility contaminants including fuel hydrocarbons in high permeability matrices such as sand and other backfill materials.

DESCRIPTION: Monitoring and quantification of releases from sources such as high pressure, high capacity fuel hydrant systems will ensure prompt remediation efforts. Current metering systems monitor at the point of discharge and are an order or two of magnitude insensitive to pick up low leakage rates.

PHASE I: Develop conceptual design, calibration procedures, and conduct bench-scale experiments to demonstrate concept viability.

PHASE II: Conduct prototype test and evaluation and demonstrate technical feasibility under field conditions.

PHASE III: Fabricate full scale unit for actual use by the Navy personnel at a field activity. develop unit to monitor leaks.

COMMERCIAL POTENTIAL: Accurate monitoring and quantification of contaminant has wide scale applications for dual-use. This system would be used for all long distance fuel piping systems.

N94-244 TITLE: Integrated Geotechnical-Geophysical Assessment Device for Offshore and Nearshore Sites.

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNICAL AREA: Environmental Quality and Civil Engineering

OBJECTIVE: To develop a device that will determine offshore soil properties and distributions directly by combining geophysical site stratification data with engineering parameter data from in situ geotechnical soil testing.

DESCRIPTION: There is a critical need for a capability to expeditiously assess bottom soil conditions for offshore construction and salvage and amphibious assault operations requiring deployment of mooring anchors, piles, etc. Geophysical surveys can provide stratification data but only qualitative material information. Geotechnical site investigation techniques (drilling, sampling and testing) provide quantitative soil data but have support, personnel and time penalties. A device combining both these techniques, would provide major benefits.

PHASE I: The contractor would select the most appropriate geophysical (or resistivity or electromagnetic, if appropriate) bottom scanning techniques and propose combining them with a "ground truthing" technique that provides soil parameter data. This latter technique could be a doppler penetrometer, instrumented cone, vibratory corer or other such device. A tentative design would be proposed based on available technology and current capabilities.

PHASE II: A system combining the two approaches could be designed, constructed and evaluated in the field under known conditions.

PHASE III: Develop a full scale system that could be used in expeditionary scenarios and that could also be utilized under more benign conditions of offshore petroleum exploration.

COMMERCIAL POTENTIAL: Major value for offshore industry including petroleum production.

N94-245 TITLE: Standard Reference Coating for Accelerated Testing or Weathering of Paints and Coatings

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Materials and Structures

OBJECTIVE: Develop reference coating system(s) to use in testing and developing high performance coatings and/or coating systems.

DESCRIPTION: The Navy must use high performance coatings to protect facilities/structures at the waterfront. Due to changes in environmental regulations, many previously acceptable coatings can no longer be used. Historical performance is not available for newer coatings manufactured to take their place. The time lag from laboratory development to manufacturing can range from 10 years to 20 years. Standard reference coatings are needed to provide a link between laboratory accelerated weathering and field or test site weathering. Also, reliable laboratory methods and statistical models must be coordinated with the reference coatings to provide accelerated weathering methods. These methods will be applied to old, new, and developing coating systems.

PHASE I: Assess current technology. Focus on at least four coating types and four coating system types to develop references on. Devise an experimental approach to test and evaluate the validity of the references and test procedure. The coatings and systems chosen should be based on usage/need. Coordinate efforts with trade group and other government organizations. Perform experimental procedure on at least one coating and one coating system. Evaluate results for Phase II.

PHASE II: Based on results from Phase I, carry out further tests on remaining coatings and coating systems chosen in Phase I. Determine best approach to supplying reference(s). Expand testing to include the remaining number of coatings and coating systems chosen in Phase I. Coordinate efforts to make the procedures developed acceptable industry standard tests such as ASTM methods. Marketing to the paint and coating industry should begin near the end of this phase.

PHASE III: There are efforts in other Government organizations that might support Phase III efforts. Also, industry trade groups may get involved at this point. Lastly, the references should be established enough at this point to begin supporting further efforts.

COMMERCIAL POTENTIAL: New coating systems will be developed to improve existing systems as well as to replace those that are no longer acceptable due to changes in environmental regulations. The Navy does not develop coating systems but does require testing of those it purchases. If reference coatings that can establish a link between laboratory testing and field exposure can be developed, this could reduce the need for long term field testing and consequently reduce the costs of developing new coatings.

NAVAL RESEARCH LABORATORY

N94-246 TITLE: Micro-Turbojet Engine

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Aerospace Propulsion

OBJECTIVE: To establish a basis for the <5" diameter, low cost gas turbine engine and prepare a proposal that would detail the applicability of a micro-system to unmanned air vehicles that are either in existence, under development, or under consideration for future projects.

DESCRIPTION: A <5" gas turbine with a specific fuel consumption no greater than 1.5 Lbs (thrust)/Hr-Lb,multiple fuel use capability,and a net thrust of at least 70 Lbs would be required to meet the mission needs of unmanned air vehicles currently under development or in study for manned aircraft defense, reconnaissance, surveillance,and ship's defense scenarios. The engine should also include an engine-driven generator concept to provide on board systems power for various systems and payloads. The high power density,on board power source capability,and light weight of the micro-turbojet engine coupled with the high performance aerodynamic technology applicable to unmanned vehicles are certain to significantly lower the overall system and mission costs to the Navy in operational scenarios.

PHASE I: Feasibility study - mission specific applications for the micro-turbine engine/UAV combination within Navy requirements. Performance tradeoffs versus conventional/current engine technologies applied to UAVs. Synthesize preliminary designs of flight weight hardware systems.

PHASE II: Fabricate flightweight hardware, engine/hardware integration, and bench testing, proving the operability in replicated flight conditions.

PHASE III: Flight test hardware; possible follow-on payload integration.

COMMERCIAL POTENTIAL: New technology could produce high output, low cost micro auxiliary power units for numerous applications.

N94-247 TITLE: Image Data Mapping, Compression, Archive and Display Software

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Software

OBJECTIVE: To develop software tools for rapid mapping, display, and storage of high resolution digital imagery from airborne and satellite sensors.

DESCRIPTION: A new emphasis in naval oceanography on the remote sensing of coastal regions requires increased use of high resolution image data such as those from airborne ocean color sensors or from airborne or satellite synthetic aperture radars. Often, preparing such imagery for display and analysis is time consuming. Data must be earth-located, mapped to a projection, and calibrated. Data from different ground stations may be in different formats, making comparisons difficult. Image files are large (a single 100km square full-resolution ERS-l SAR scene, for instance, is 64Mb). This makes it difficult to review data for both large and small scale features at the same time. A flexible software tool is needed to: l) Read data files (Software would automatically determine format). 2) Map data (earth locate in a designated projection) using information in header or header file (user would cue program as to what fields to use), or using user supplied information. 3) Calibrate data, if necessary, again using information in header if available. 4) Store data in archived, compressed form. 5) Allow the user to mosaic image files using fields (such as date or time) in the archive data base as selection criteria. This feature would automatically assemble individual frames into strips representative of a satellite pass, or assemble multiple passes into a larger view of a region. 6) Allow the display of an entire image or mosaic at reduced resolution, with pan and zoom capabilities at various resolutions, without noticeable delay. 7) Allow the extraction (with earth location information) of displayed image regions for further analysis. Software must run on Sun and Silicon Graphics workstations. Source code must be provided.

PHASE I: Prototype system to read CEOS format SAR data files from various ground stations and provide the functions listed above.

PHASE II: Expansion to accommodate aircraft data and formats other than CEOS.

PHASE III: Add improved image compression ability.

COMMERCIAL POTENTIAL: The potential to market software as a flexible user friendly tool for injest and display is high.

N94-248 TITLE: Improved Sources for MBE (Molecular Beam Epitaxial) Growth of Nitrogen-Based Materials

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Sensors/Materials

OBJECTIVE: Develop Nitrogen sources for utilization in conventional III-V MBE machines. These sources should enhance the rates currently attainable for MBE growth of nitrides.

DESCRIPTION: Wide bandgap alloys based on aluminum nitride, gallium nitride and silicon carbide offer considerable promise for future optical (solar-blind detectors) and RF (high temperature, high power) applications. Although progress has been made in the growth and doping of these materials, the materials technology is still very immature. MBE is one of the most promising approaches to controlled growth and doping of this family of materials and the limited flux rate of current nitride sources is a major problem. Techniques are required to increase the ratio of atomic-to-molecular species.

PHASE I: Develop a first-generation nitrogen source for conventional III-V MBE systems.

PHASE II: Phase II will develop manufacturing techniques for the prototype source developed in Phase I. It would make the prototype compatible with the wide variety of MBE machines currently in the field.

PHASE III: Pending the results of Phase II.

COMMERCIAL POTENTIAL: Devices based on this technology are potentially useful for RF transmitters for local area networks, wireless communications and satellite broadcasting. They could also have utility in high temperature environments such as aircraft or automobile engine monitoring.

N94-249 TITLE: Simulation of Fire in a Virtual Environment

CATEGORY: Exploratory Development

SERVICE CRITICAL TECHNOLOGY AREA: Training Systems

OBJECTIVE: To develop devices for sensory feedback across user interface of fire-generated parameters, e.g., radiant heat, smoke, humidity, without harmful effects to hardware or user.

DESCRIPTION: To use the virtual environment as a training tool for Navy fire fighters, the hazardous characteristics of fire must be realistically simulated to the extent that the user feels immersed in the environment. This realism must be accomplished without compromising the fire fighter's safety but must replicate the actual environment so that the desired training effect can be achieved. Although parameters such as smoke density and radiation profiles can be displayed quite effectively in a graphical mode, still lacking understanding are what human perceptions need to be triggered to simulate the trainee choking from smoke inhalation, searing heat of steam, or being burned by the radiant heat from the flames.

PHASE I: Determine the type and amount of sensor information that should be available to the user to maximize the training effect in fire fighting environment and techniques by which this can be accomplished.

PHASE II: Develop and test sensors that will achieve the resolution and sensitivity needed to meet the informational requirements formulated under Phase I.

PHASE III: Develop prototype hardware with multisensor feedback that can be interfaced with a user to provide information progressing in time from simulated fire.

COMMERCIAL POTENTIAL: New technology will be applicable to the civilian sector in both operational and training hardware that could be integrated into the fire service.

AIR FORCE

PROPOSAL PREPARATION INSTRUCTIONS

The responsibility for the implementation and management of the Air Force SBIR Program is with the Air Force Materiel Command Deputy Chief of Staff for Science & Technology. The Air Force SBIR Program Manager is R. Jill Dickman. Do NOT submit SBIR proposals to the AF SBIR Program Manager under any circumstances. Inquiries of a general nature or problems that require the attention of the Air Force SBIR Program Manager should be directed to her at this address:

Department of The Air Force
HQ/AFMC/STXB (AF SBIR Program Manager)
4375 Chidlaw Rd
Suite 6
Wright-Patterson AFB OH 45433-5006

No additional technical information (this includes specifications, recommended approaches, further refinement, the limiting of topic areas, and the like) can or will be made available by Air Force personnel during the solicitation period. The only source for technical information is the Defense Technical Information Center (DTIC). Information is key to successful proposal preparation and research; however, locating pertinent information is often difficult. For this reason the DoD SBIR Program is working on better ways to serve the small business community with information support. Additional references are available for each topic in the Technical Information Packages (TIP) prepared by DTIC. Please refer to section 7.1 in this solicitation for further information on DTIC.

The maximum amount of SBIR funding used for any Air Force Phase I award shall be $60,000. Also firms are encouraged to submit a proposal for an option task which would be performed during the period between Phase I completion and Phase II contract award not to exceed $20,000. The basic Phase I proposal shall be evaluated exclusive of the option task and must therefore be proposed and priced separately. Any option proposal must be submitted at the same time and place as the basic Phase I proposal and shall not be included in the basic Phase I limitation to not exceed 25 pages. The option shall detail work that would logically transition a feasibility determination during Phase I into a practical application during Phase II. The transition work shall be included as an option in the Phase I contract and evaluated for unilateral Air Force exercise at any time after Phase I award through the conclusion of the Phase I contract reporting period. Exercise of any option shall be at the sole discretion of the Air Force and shall not obligate the Air Force to make a Phase II award. It is anticipated that the option portion of the proposal shall be 10 pages or less, not exceed $20,000, not exceed 3 months in duration, and be evaluated using the same evaluation criteria as for Phase I. Any resultant Phase I contract containing an option shall include a provision that sets forth the Air Force right to obtain the option effort at the previously agreed to price by providing written notice of same on or before the conclusion of the Phase I contract reporting period.

AIR FORCE PROPOSAL SUBMISSION INSTRUCTIONS

For each Phase I proposal, send one original (with red appendices A and B) and three (3) copies to the office designated below. Also, send an additional set of red appendices A and B, which are not stapled or mutilated in any way. Be advised that any overnight delivery may not reach the appropriate desk within one day.

TOPIC NUMBER	ACTIVITY/MAILING ADDRESS (Name and number for mailing proposals and for administrative questions)	CONTRACTING AUTHORITY (For contractual questions only)
AF94-236 thru AF94-247	Technology Transition Office ASC/SMTP (Gerry Cazzell) 2690 C Street, Suite 5 Building 22 Wright-Patterson AFB, OH 45433-7412 (Gerry Cazzell 513-255)	
AF94-248 thru AF94-251	Human Systems Center Armstrong Laboratory (AL/XPTT) SBIR Program Manager 2509 Kennedy Circle Bldg 125, Room 201 Brooks AFB TX 78235-5118 (Belva Williams, 210-536-2103)	Sharon Shen (512) 536-9393

INDEX OF AF FY94 SBIR TOPICS

SUBJECT/WORD INDEX TO THE AIR FORCE SBIR SOLICITATION

AIR FORCE TOPIC DESCRIPTIONS

AF94-236 TITLE: Multipurpose Radio Frequency (RF) Test Antenna Coupler

CATEGORY: Exploratory Development

OBJECTIVE: Develop a multipurpose over-the-antenna "hat" for coupling RF avionics signals

DESCRIPTION: This requirement is for the development of non-disruptive, RF-signal injection technology. A hat for coupling RF signals must be placed over antenna apertures. This hat must be RF transparent. RF coupling must be RF transparent with minimal reflections. This system should augment free-space radiation testing and must not interfere with other free-space radiation sources. This coupler should be able to simulate dynamic angles of multiple targets within a beam width of one degree for each target. The angular coverage should be 180 and 90 degrees in azimuth and elevation, respectively. When integrated with a radar target generator and other aircraft systems, this design can be used to support dynamic integrated systems testing. Both signal transmission and reception directions are required.

Phase I will include an analytical study of the feasibility and a proposed system design.

Phase II of the investigation will be a functional demonstration of the system prototype in the Benefield Anechoic Chamber at Edwards AFB CA.

Dual Use Commercialization Potential: Both commercial aircraft and automotive industries could benefit from improved testing capability as well as any other industry with the need to test stand-alone and/or installed RF equipment.

AF94-237 TITLE: Compensation of Free-Space Signal Propagation Errors

CATEGORY: Exploratory Development

OBJECTIVE: Develop a methodology to compensate and correct for the corruption of Free-Space Signal Propagation in Anechoic Chambers induced by multipath reflections and other error sources.

DESCRIPTION: This is a requirement for the technology of correcting radio frequency signals for the effects of multipath radiation. One of the main sources of Signal Propagation Errors in Anechoic Chambers are multipath reflections from Radar Absorbing Material. Multipath errors in signal propagation are the result of forward an/or back-scattered signal propagation paths that deviate from the direct path of propagation. When these signals combine together, they may interfere constructively or destructively with the direct path signal. There is a need to develop a methodology or technique to reduce these errors. A correction or compensation process would reduce the level of signal error induced by multipath signal propagation. By reducing these signal propagation errors, the fidelity of free-space signal propagation in anechoic chambers would be greatly enhanced.

Phase I of the investigation will include a concept feasibility analysis and a proposed design of the system components (hardware/software) to compensate for these signal propagation errors.

Phase II of the investigations will include the primary research required and a functional demonstration of the system.

Dual Use Commercialization Potential: Application of radio signal propagation correction techniques may have application in improving the quality and speed of digital signal transmission in commercial microwave and satellite systems.

AF94-238 TITLE: Low-Cost Antenna with Low-Radar Cross Section (RCS) for Radio Frequency (RF) Anechoic Chambers

CATEGORY: Exploratory Development

OBJECTIVE: Develop a low-cost, low-RCS, broadband, controllable antenna system for use in RF anechoic test chambers.

DESCRIPTION: This requirement is for the development of the technology of low-cost, low-RCS, broadband, controllable antenna system for application in RF anechoic test chambers. The goal is to span the 0.5 to 18 GHz frequency spectrum, with selectable polarization and selectable gain and beamwidths. Large anechoic chambers have the need for developing large RF array systems. Due to the large quantity of antennas needed, the unit cost must be low. When these arrays are placed within the chamber, the anechoic properties of the chamber must be preserved by installing antennas of low RCS. The proposed antennas will be installed within a controlled environment.

Phase I will conduct a feasibility analysis and propose a design.

Phase II will complete a final design and construct prototype antennas and demonstrate tests in the Benefield Anechoic Facility at Edwards AFB CA.

Dual Use Commercialization Potential: Low-cost, broadband, controllable antennas have applications in commercial anechoic facilities for testing of satellite systems and other communication devices. Potentially, this type of antenna technology could be applied to direct broadcast home television systems.

AF94-239 TITLE: Navigation/Hypersonic Sled Testing/Radar Cross Section Measurements

CATEGORY: Advanced Development

OBJECTIVE: Develop innovative systems or subsystems for advanced aerospace and weapons applications in support of Navigation/Hypersonic Sled Testing/Radar Cross Section Measurements

DESCRIPTION: Proposers may submit ideas to enhance performance of systems or subsystems specified in a-c below. Two divisions and one test squadron perform a full spectrum of basic and applied research including exploratory and advanced development.

a. The Guidance Test Squadron, also known as the Central Inertial Guidance Test Facility (CIGTF) is the DoD focal point for inertial navigation, guidance, and space-based radio navigation systems (such as Global Positioning System (GPS). Current development initiatives include the Navigation Test and Evaluation Laboratory; Ring-laser and cryogenic gyro development; Submeter Accuracy Reference System; Improved Three-Axis Test Table (a precision rate and positioning fixture used for testing space-based pointing and stabilization gyros and accelerometers); and Stellar Aided Test Capability. The objective is to improve the operational readiness and effectiveness by developing technologies which will enhance or modify current methods of aerospace navigation.

b. The Test Track Division conducts tests on high priority weapon systems for all three military branches of service. Tests include (but are not limited to) aircrew escape systems certification; hypersonic lethality tests to prove performance of theater missile defense warheads against threat warheads; ballistic missile guidance system tests with recovery of test item; hypersonic kinetic energy penetrator tests; aerothermal erosion tests of radome material; weapon dispenser performance; Infrared missile warning receiver effectiveness evaluation. The goals of the Test Track Division include understanding the limitations of mechanical stresses (noise, vibration, thermal, acceleration, and impact); providing design criteria for weapon system development/enhancement, and proposing protection devices.

c. The Radar Target Scatter (RATSCAT) Division performs signature measurements in support of DoD's electronic combat effort. It operates/maintains two signature measurement facilities; provides antenna pattern measurements, range characterization, and radar cross section (RCS) measurements of full-scale rockets, missiles, reentry vehicles, aircraft, ordnance and stores, as well as for radar absorbing materials, chaff, trucks, and other ground-based objects; conducts Phase, GLINT, high range resolution imaging, effective radiated power, antenna gain, and RCS measurements; designs and uses detailed physical and computer models for use in backscatter measurements. To meet the increasing test requirements, advanced materials applications and low observable design/analyses are also performed.

AF94-240 TITLE: Centrifuge Testing of INS/GPS Systems

CATEGORY: Advanced Development

OBJECTIVE: Develop the capability to test a GPS/INS integrated system on a precision centrifuge.

DESCRIPTION: The Central Inertial Guidance Test Facility (CIGTF), Holloman AFB, NM tests inertial navigation systems (INS) that have embedded Global Positioning System (GPS) receivers. Precision centrifuge tests are standard during the qualification of an INS, and are needed for embedded systems. The capability to perform a precision centrifuge test of an embedded system currently does not exist as the centrifuges are contained within metal structures so satellite signals required by the GPS receiver are not available. Both inertial and GPS technologies cannot be exercised simultaneously which leads to a sub-optimal environment for evaluating many types of guidance or navigation system errors. An advancement in the state-of-the-art in test bed equipment and technology is required to provide an adequate solution.

Phase I: Research into the feasibility of testing an integrated INS/GPS system on an existing CIGTF precision centrifuge utilizing revolutionary and innovative methods of exciting the on-board GPS receiver. Since current methods are inadequate, significant advancements in both live and simulated satellite signal scenarios should be pursued.

Phase II: Research into the design of the candidate system including software and hardware design and installation and checkout of a prototype.

Dual Use Commercialization Potential: Potential exists in the inertial industry, commercial aviation industry, and the automotive industry.

AF94-241 TITLE: Light/Flame Penetrating Motion Picture Photography

CATEGORY: Advanced Development

OBJECTIVE: Develop a reliable method to optically observe phenomena obscured by excessive light and heat.

DESCRIPTION: Various types of warhead and impact tests are conducted at the High Speed Test Track. During these tests, it is important to observe the movement of fragments, submunitions or targets while they are totally enveloped in flame and combustion products. The heat and light generated prevent the observation of these items by conventional photographic means. A method to observe the motion of theses items, that is not obscured by the intense light and heat generated, is required.

Phase I: Determine the feasibility of observing the motion of items obscured in light and flame.

Phase II: Design, build and demonstrate a prototype system capable of recording the motion of items obscured in flame and light.

Dual Use Commercialization Potential: The system has application in optically observing phenomena that occurs in blast furnaces, reactors, or in manufacturing processes such as welding or cutting metal.

AF94-242 TITLE: Bistatic Radar Cross-Polarized Calibration Methodology

CATEGORY: Advanced Development

OBJECTIVE: Develop a valid methodology for calibrating the cross-polarized response from an instrumentation radar.

DESCRIPTION: Bistatic radar signature refers to the electromagnetic scattering response of a target in directions other than toward the radiation source. Although a variety of radar calibration techniques have been developed for a bistatic configuration, there is no valid calibration techniques for a bistatic cross-polarized response (transmit one polarization, receive another). The key element of this research will be to develop a calibration device whose theoretical signature can be accurately characterized. Design constraints will include minimal interaction with target-support structures, adequate background isolation, orientation insensitivities, and usable over a wide frequency range (typically 1-36 GHz).

Phase I: Propose a calibration device, and theoretical model to accurately describe this device. Final a report shall include a proposed methodology for using this device at a static outdoor measurement facility with all design constraints considered.

Phase II: Complete the development and construct a prototype of calibration device. Demonstrate the proposed calibration methodology at the 46 Test Group Radar Target Scatter Division (RATSCAT), Holloman AFB NM. Correlate theoretical values to measure values over the frequency range of interest to validate the proposed methodology.

Dual Use Commercialization Potential: Radars continue to have extensive value to DoD, government, and private industries. Accuracy and precision continue to be driving design factors. Inherent in this is the need for accurate calibration devices and methods. As Bistatic radar signatures become the next radar generation arena, development of bistatic calibration methodologies will have immediate application in developments for both the public and private sectors. Examples include air traffic control and approach radars.

AF94-243 TITLE: RF Radiation Absorbent Material (RAM) Over Heating Detector

CATEGORY: Exploratory Development

OBJECTIVE: Develop a Thermal Imaging System for the early detection of RAM overheating.

DESCRIPTION: The capability of RAM used within anechoic test chambers has reached safety limits to absorb Radio

Frequency levels of modern radar systems. As RAM is heated, with RF energy, to their combustion temperature, burning internal to RAM may be initiated and erupt into fires hours after the RF energy has been stopped. To prevent the occurrence of RAM combustion and RAM damage due to overheating, a system to detect the presence of overheating of RAM in large anechoic chambers (over 100' X 100' X 40') is required. The purpose of this effort is to develop a real-time RAM heat monitoring system for the early prediction of RAM overheating. This system must be capable of detecting and locating hot spots in RAM within the anechoic chamber prior to initiation of combustion.

Phase I: Perform a technical feasibility analysis and propose system design.

Phase II: A prototype will be constructed and demonstration tests will be conducted in the Benefield Anechoic Facility of Edwards AFB CA.

Dual Use Commercialization Potential: Technologies of detection of overheating components in large areas has potential application fire prevention systems in commercial facilities. In commercial anechoic facilities this type of system has application to prevent potential fires in overheated RAM.

AF94-244 TITLE: Automatic Reconfiguration of Model Interfaces

CATEGORY: Exploratory Development

OBJECTIVE: Develop a computerized technique for interfacing scientific Models and Simulations (M&S)

DESCRIPTION: This requirement is for development of the technology to automate the data interface between scientific computer models. Most of the veriflex and validated scientific M&S programs. Consequently each model or simulation tends to define its own data and formats such that using models together is difficult. What is needed is a computerized technique for recognizing and capturing the output of each model and reformatting it as necessary for use as Input to other models. Such data sharing must be possible in real-time systems where data are buffered and shared incrementally, not just in non-real-time systems where data might be translated exclusively for only one other model input.

Phase I should result in a technical feasibility analysis and proposed system design.

Phase II should result in development of the option, and a demonstration of a prototype system which can share data among at least three scientific electronic combat M&S programs in real-time. The common (shared) format should support a recognized standard; e.g. J-MASS.

Dual Use Commercialization Potential: A product and schema which will effectively and efficiently translate ADA M&S into data transfer compatible routines would enable over thirty years of valuable software models and simulations to be used in development of improved M&S products.

AF94-245 TITLE: Intelligent Translation of FORTRAN to ADA

CATEGORY: Exploratory Development

OBJECTIVE: Develop a computerized technique for intelligent translation of FORTRAN code to ADA code

DESCRIPTION: This requirement is for the technology of an intelligent FORTRAN to ADA Translator which will incorporate unique ADA language capabilities in the translation. Most of the verified and validated scientific models and simulations (M&S) in current use were written years ago and are in FORTRAN. Today there are many advantages to using ADA. Rewriting millions of lines of FORTRAN in ADA would be labor intensive and error prone and very expensive. Current translators tend to make a "line by line" transliteration sometimes said to be the worst of both languages. An intelligent translator should capture the meaning of large sections of code, e.g., entire FORTRAN subroutines. And it should translate the idioms in FORTRAN to appropriate expressions in ADA. Finally it should impose some of the software engineering capability of ADA on the product.

Phase I should result in a technical feasibility analysis and proposed system design.

Phase II should result in the completion of the system and a demonstration of a prototype translator which converts actual scientific electronic combat M&S FORTRAN code to working ADA code.

Dual Use Commercialization Potential: Effective and efficient FORTRAN to ADA translation would enable over thirty years of valuable software models and simulations to be moved into future technology products.

AF94-246 TITLE: Development of non-chromate coatings for aluminum and magnesium in aircraft applications

CATEGORY: Advanced Development

DOD TECHNOLOGIES: Materials & Environmental Quality

OBJECTIVE: Develop corrosion protection coatings with a minimal environmental impact

DESCRIPTION: Chromate conversion coatings are used for corrosion prevention prior to the painting of aircraft. The Air Force would like to reduce the amount of chromate that is released during the coating and decoating processes by finding an alternative coating material which does not contain chromate compounds. This alternative aircraft coating material must have minimal detrimental impact upon the environment.

Phase I: Phase I will address initial formulation, fabrication, evaluation, and application techniques of specific subjects for proof on concept.

Phase II: Phase II will further develop and optimize the material and/or application techniques, and produce larger samples for a full spectrum of evaluations.

Dual Use Commercialization Potential: The requirements to comply with environmental regulations applies equally to the commercial coating industry. As such, much of the technology developed for compliance of military coating systems could be extended to commercial applications. Commercialization of the technology would involve scale-up to production capacity, and production of sufficient quantities of material to coat aircraft or other large objects using an environmentally complaint and commercially viable application techniques.

AF94-247 TITLE: Non-isocyanate Based Polyurethane Paints

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Materials & Environmental Quality

OBJECTIVE: Develop polyurethane paints that do not contain isocyanate compounds for Air Force equipment.

DESCRIPTION: The Air Force is interested in the research and development of coatings with minimal detrimental impact upon the environment. Of primary interest is the development of coatings that do not contain isocyanate compounds and are equal to or exceed the performance of Military Specifications, Mil-C-83286. The coating must meet low VOC and IR requirements. The application of these coatings are to include the initial coating procedures and any touch-up. This coating must be able to be applied to aircraft, aircraft ground support equipment and other Air Force equipment.

Phase I: Phase I will address initial formulation, fabrication, evaluation, and application techniques of specific subjects for proof on concept.

Phase II: Phase II will further develop and optimize the material and/or application techniques, and produce larger samples for a full spectrum of evaluations.

Dual Use Commercialization Potential: The requirements to comply with environmental regulations applies equally to the commercial coating industry. As such, much of the technology developed for compliance of military coating systems could be extended to commercial applications. Commercialization of the technology would involve scale-up to production capacity, and production of sufficient quantities of material to coat aircraft or other large objects using an environmentally compliant and commercially viable application techniques.

AF94-248 TITLE: Fugitive Emissions Detection System

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop a detection system for fugitive emissions in industrial applications.

DESCRIPTION: This requirement is for an emission detection system that is capable of operating under a wide range on environmental conditions. There is a need for a system that provides early warning of potential seal failures for compressors, valves, pumps, flanges, and other piping facilities which might cause fugitive emissions.

Phase I: Phase I would be to develop a system design specification and to perform preliminary requirement allocation and design for pumps, valves, and flanges that would meet the Federal and California Regulations. Federal Regulation 40 CFR Chapter 1, issued pursuant to the Clean Air Act, requires compressors, valves, pumps, and other piping facilities which might create fugitive emissions to be monitored on a regular basis with appropriate reporting and penalties for excessive failure. In California, even stiffer requirements and penalties (S.C.A.Q.M.D. Rule 1173) are being adopted and other areas are to follow. Present regulations dictate the use of continuous monitoring of seals to detect early failure. A superior system would detect incipient failure and give an electrical, visual, and/or audio signal of a potential problem. This would allow time for preventive action prior to any emission taking place. Detector systems must consider fire, wide temperature excursions, and wide ranging internal/external environments. They should be compatible to the maximum extent possible with existing flange, pump, and valve designs. In addition, they should be more economic than existing monitoring systems.

Phase II: Phase II would provide the risk assessment, develop a prototype design, testing requirements, and perform laboratory and/or field demonstration tests to insure the proposed design works and interfaces with existing piping and equipment.

Dual Use Commercialization Potential: This system will have wide spread use in the commercial field because of its application to industrial/manufacturing equipment.

AF94-249 TITLE: Environmental Engineering Research

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop innovative ideas/concepts in the area of compliance and site remediation environmental engineering.

DESCRIPTION: Environmental engineering research includes the following areas: environmental modeling, to include fate and transport in soils and groundwater and air toxins; sensor development, testing, and integration for hazardous waste site characterization and monitoring; chemical/process engineering, including process modification and process control; in-situ and on-site biological treatment technologies, including site remediation and process waste treatment; and chemical/physical treatment technologies, including site remediation and process waste treatment technologies; and concepts to eliminate, substantially reduce, or mitigate environmental consequences of future Air Force weapons systems.

Dual Use Commercialization Potential: Technologies in these areas are common to many DoD and commercial/industrial requirements.

AF94-250 TITLE: Occupational and Environmental Health Research

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop ideas/concepts in risk analysis, toxicity, pollution assessment, hazardous materials, and directed energy technology.

DESCRIPTION: This requirement is for the Occupational and Environmental Health Directorate which is responsible for assessment and mitigation of risks to human and environmental health from hazardous materials, noise, and electromagnetic radiation exposures associated with Air Force operational and occupational missions. This work supports, in large part, Air Force compliance with federal, state and local regulations governing environmental, safety, and occupational health, e.g. OSHA, AFOSH, Clean Air Act, Clean Water Act, RCRA, ATSDR, etc. The work is accomplished through seven functional areas:

(1) Analytical Chemistry Services provides support to Air Force environmental pollution control programs. They respond to over 250 base level customers who send over 100,000 samples annually. Novel approaches to measuring and analyzing exposure to hazardous materials in air, water, soil, and vegetation (occupational and environmental applications) are sought. (2) Research and development activities for Bioenvironmental Engineering Services support environmental monitoring and compliance technologies for noise, ionizing and nonionizing radiation, toxic emissions into air, water, and soil, and hazardous material handling and abatement. (3) Occupational Medicine requires the ability to rapidly access health hazard information and to employ modern methods for exposure estimation to conduct occupational and environmental hazard assessments. (4) Optical Radiation Division conducts research on high energy density visible light, with special requirements in laser bioeffects and laser eye protection. (5) The Radiofrequency Radiation Division conducts research on the bioeffects of radiofrequency and microwave radiation with requirements in central nervous system effects at the cellular level. (6) The Mathematics Division conducts research on the analytical and modeling aspects of biomedical hazards of directed energy with requirements in tissue level interactions. (7) Toxicology research investigates the hazards of Air Force chemicals and materials on humans and the environment with requirements in tissue dose estimation and injury mechanisms for hazard analyses.

Dual Use Commercialization Potential: The scope of work of the Occupational and Environmental Health Directorate impacts areas of interest that qualified small businesses work in. e.g., all human centered technology assessments to create a safer work place for Air Force personnel as well as determinations for the general public that the Air Force is a non-polluting "good neighbor." To meet that goal, clean air, clean water, materials toxicity, and directed energy source safety monitoring are required in the form of risk analysis, toxicity, pollution assessment, hazardous materials, and directed energy technology.

AF94-251 TITLE: Non-Aqueous Phase Liquid Detection by Seismic or Electromagnetic Imaging

CATEGORY: Exploratory Development

DOD TECHNOLOGIES: Environmental Effects

MAJOR S&T THRUST: Environmental Quality

OBJECTIVE: Develop methods to detect both light and dense non-aqueous phase liquids (LNAPL and DNAPL).

DESCRIPTION: Past disposal and handling practices for hazardous materials have resulted in subsurface contamination by fuels and solvents at many Air Force sites. Typically, fuels and chlorinated solvents lie on the top (LNAPL) or bottom (DNAPL) of an aquifer and slowly diffuse into groundwater, creating a long-term source of contamination. Currently there is no technology specifically aimed at detecting or monitoring the bulk fuel or solvent material that floats or sinks within the subsurface, in contact with the aquifer. Also, existing characterization/monitoring methods are labor intensive, complex, costly, and may produce invalid and unreliable results. This research will develop a system which characterizes and images LNAPL and DNAPL waste, and other objects within the subsurface. The use of geophysical techniques integrated with the cone penetrometer have potential for meeting this requirement. The proposed system may use pulsed seismic or electromagnetic sources to probe the subsurface. Subsurface radiators associated with the cone penetrometer will direct a seismic or electromagnetic pulse into the earth; and other subsurface receivers emplaced by a cone penetrometer will detect the transmitted pulses. Computer analysis of the detected signals will define the extent and type of underground deposits. An image will be produced through the computation of a pointwise soil dispersion curve (the dielectric constant and conductivity as a function of frequency). Development of such a system will accelerate environmental surveillance and waste location, and greatly reduce the number of soil samples needed to reliably detect contamination. By identifying the source of contamination, remediation efforts will be better targeted, allowing more efficient and cost-effective cleanup of these difficult sites. Cost savings to the Government could easily be millions of dollars annually.

Phase I: Phase I is expected to address Air Force requirements to develop technologies to characterize sites contaminated with fuels and solvents consistent with the tri-service roles and responsibilities established under Project Reliance.

Phase II: Due to the magnitude and urgency of these requirements, normal scope and funding limitations do not apply.

Dual Use Commercialization Potential: There is a significant commercial market for such a system as this will be a dual-use technology. The DoD uses contractors to conduct remediation at thousands of contaminated sites, as do the DoE and EPA. There is also a large number of contaminated sites created by industry, not associated with activities of any department or agency of the federal government, which will require remediation.

ADVANCED RESEARCH PROJECTS AGENCY

Submission of Proposals

The responsibility for carrying out ARPA's SBIR Program rests with the Office of Administration and Small Business. The ARPA Coordinator for SBIR is Ms. Connie Jacobs. ARPA invites the small business community to send proposals directly to ARPA at the following address:

ARPA/OASB/SBIR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714
(703) 696-2448

The proposals will be processed in the Office of Administration and Small Business and distributed to the appropriate technical office for evaluation and action.

ARPA has identified 20 technical topics, numbered ARPA 94-087 through ARPA 94-106, to which small businesses may respond in the second fiscal year (FY) 94 solicitation (94.2). Please note that these are the only topics for which proposals will be accepted at this time. Proposals can no longer be accepted on those previously advertised 86 technical topics which were numbered ARPA 94-001 through ARPA 94-086. A list of the topics currently eligible for proposal submission is included below, followed by full topic descriptions. The topics originated from ARPA technical offices.

ARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the ARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military and dual-use applicability as the budget and other factors will allow. In the early years of the SBIR program, most of the promising Phase I proposals could be funded, but as the program's popularity increased, this became more and more expensive. ARPA therefore instituted program changes to fund more Phase Is. These included increasing the number of SBIR topics, and setting more funds aside for Phase I proposals. In order to do this and still have a reasonable amount of funds available for the further development of promising Phase Is, the Phase II awards are limited to $375,000; however, additional funding may be available for optional tasks. Phase I awards are limited to $99,000. Gap funding is not available.

ARPA selects proposals for funding based upon technical merit and the evaluation criteria contained in this solicitation document. As funding is limited, ARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the ARPA mission. As a result, ARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) in question is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to ARPA must have a topic number and can only respond to one topic.

ARPA has prepared a checklist to assist small business activities in responding to ARPA topics. Please use this checklist prior to mailing or hand-carrying your proposal(s) to ARPA. One additional photocopy of Appendices A & B is requested. Do **not** include the checklist with your proposal.

ARPA 1994 Phase I SBIR

Checklist

1) Proposal Format

a. Cover Sheet - Appendix A (identify topic number) ______

b. Project Summary - Appendix B ______

c. Identification and Significance of Problem or Opportunity ______

d. Phase I Technical Objectives ______

e. Phase I Work Plan ______

f. Related Work ______

g. Relationship with Future Research and/or Development ______

h. Potential Post Applications ______

i. Key Personnel ______

j. Facilities/Equipment ______

k. Consultants ______

l. Prior, Current, or Pending Support ______

m. Cost Proposal - Appendix C ______

n. Prior SBIR Awards

2) Bindings

a. Staple proposals in upper left-hand corner. ______

b. <u>Do not</u> use a cover. ______

c. <u>Do not</u> use special bindings. ______

3) Page Limitation

a. Total for each proposal is 25 pages inclusive of cost proposal (Appendix C) and resumes. ______

b. Beyond the 25 page limit do not send appendices, attachments and/or additional references. ______

4) Submission Requirement for Each Proposal

a. Original proposal, including signed **RED** Appendices A and B. ______

b. Four photocopies of original proposal, including signed Appendices A and B. ______

c. One additional photocopy of Appendices A and B only. ______

INDEX OF ARPA FY 94.2 TOPICS

SUBJECT/WORD INDEX TO THE ARPA FY94.2 TOPICS

ARPA FY94.2 TOPIC DESCRIPTIONS

ARPA 94-087 TITLE: Variable Frequency AC Motor Controller Using MCTs

CATEGORY: 6.2 Exploratory Development; Propulsion and Vehicular Systems

OBJECTIVE: Develop a Four-Quadrant AC Induction Motor Controller Using MOSFET Controlled Thyristors (MCTs)

DESCRIPTION: MOSFET Controlled Thyristors (MCTs) are presently available at ratings of 65 amps and are projected to be available at ratings over 100 amps in the near future. MCTs have the potential to provide higher switching frequencies and higher voltage capabilities than Insulated Gate Bipolar Transistors (IGBTs). Higher operating voltages and higher switching frequencies are necessary to obtain high power density components for the land propulsion systems of future military land vehicles. Pending the availability of MCTs with higher power ratings, the application of the 65 amp MCT is sought in military utility vehicles, such as a battery-powered electric pickup truck. An advanced power controller that uses MCT switches, is sought for the control of a 50 to 100 horsepower AC induction motor. The controller must provide full four-quadrant control. The offeror may use an existing AC motor capable of providing a 4,200 pound truck with a maximum speed of 60 miles per hour and a maximum gradeability of 20 percent.

Phase I: Design a full control system and test MCT components for a four-quadrant motor controller using the largest MCT rating that is commercially available at the time of design. The motor controller must provide smooth control of vehicle speed and torque under the full range of operating conditions. The controller must operate from a fixed battery voltage (consistent with the selection of a traction motor) and must offer good motor efficiency over the full operating envelope. The final report should include: full design details including schematics, results obtained from MCT laboratory tests, and an integration and test plan for Phase II vehicle testing.

Phase II: Construct and test the four-quadrant MCT-based controller in a Government furnished electric pickup truck. The Government pickup truck may be assumed to be an S-10 class vehicle equipped with an AC motor and an IGBT-based controller. The Phase II effort should include a complete test plan for the finished vehicle, an evaluation of the efficiency and performance the MCT controller, and a business plan for commercial development of an MCT-based controller.

COMMERCIAL POTENTIAL: Significant commercial potential exists with current and future commercial vehicles.

ARPA 94-088 TITLE: Autonomous Solid-State Position/Attitude Reference Subsystem for Head-Mounted Display System

CATEGORY: 6.2 Exploratory Development; Human-Systems Interfaces

OBJECTIVE: Develop and prototype a self-contained precision reference subsystem (RS) to provide real-time position/attitude data to a visualization system for head-mounted displays.

DESCRIPTION: Meaningful real-time visualization for synthetic environments requires precise knowledge of the viewpoint of the observer. Synthetic environments include simulation used for a vast and disparate array of purposes, such as training of military personnel in combat operations, education of students in historical re-creations, practice of medical techniques, and extrapolation of scientific and numerical analysis into three-dimensional animation. Common among all these applications of simulation is the need to geo-locate the observer's eye-point and field of regard with sufficient accuracy and timeliness to enable the visualization system (whatever it may be, independent of this topic) to generate and display the appropriate viewpoint. The viewpoint must be dynamically updated at a rate that provides no perceptible lag to the observer; i.e., total system (reference and visualization subsystems) updates must be faster than observer perception threshold. Lag is manifested as the tendency for display motion to "fall behind" an observer's head motion, or to even slew in the opposite direction of the observer's rapid head movements. Nominally, the reference subsystem should be capable of continuous complete state vector update at 60 Hertz. It may output the state vector at lower rates using Distributed Interactive Simulation (DIS) Protocol Data Units (PDUs), and utilize PDU dead-reckoning algorithms to reduce data transmission requirements. The RS state vector should consist of all timing, roll, pitch, yaw, x, y, and z, and all their various acceleration values necessary to detail the dynamic observer viewpoint. The RS must contain all necessary firmware to perform all computations and output. The RS sensors should be independent of and be adaptable for use with a variety of head-mounted display devices. The RS should be autonomous in that it cannot require physical connection to anything off-board the observer; i.e., no trailing power or data cables. The RS could make use of unique mixtures of reference input, such a geo-referenced, augmented differential Global Positioning System (GPS) data, combined with inertial solid-state micro-electronic accelerometers and gravity referenced tilt meters. The system could utilize off-board (off of observer) artificial pseudo-GPS constructs, such as external arrays of pulse-code modulated (PCM) infrared diodes to provide differential location and angular displacement deltas. The absolute location accuracy indicated by the RS in relation to the external world must be self-consistent among all similar devices operating within the same synthetic environment. The relative dynamic accuracy of the state vector output from each RS must be within 0.01% of the depth of the observed synthetic environment in x, y, and z (1 millimeter reference accuracy for a 10 meter deep visual scene), and 0.001 radian in roll, pitch and yaw.

Phase I: Design an autonomous solid-state position/attitude RS for head-mounted display systems; bread-board critical elements thereof to demonstrate feasibility of the approach. Design the software to provide the state vector interchangeable either as DIS PDUs or as engineering data. For the DIS PDU case, provide for the dead-reckoning algorithms on-board the RS, and analyze the changing data output rate requirements for both cases. Explore the use of an "inverted GPS range" using PCM infrared diodes to provide position cues to the RS, and the use of gravity referenced tilt meter and solid-state accelerometers for attitude and motion measurements. Analyze the utility of actual differential GPS as a data source for gross and inter-observer position reference. Design and plan a total system demo to include the pairing with a high-end visualization subsystem and appropriate head-mounted display subsystem, and at least three different types of high-fidelity three-dimensional databases consistent with the simulation topics above. Provide the results of all analyses.

Phase II: Prototype and demonstrate the interoperation of the reference subsystem as designed and planned in Phase I, demonstrating at least two independently operating integrated RS in at least the three databases planned for in Phase I. Provide test results and data to support design decisions and performance. Extrapolate the cost of producing the reference subsystems for mass use. Document the complete interface specifications for generic integration of the RS.

COMMERCIAL POTENTIAL: Successful development of this reference subsystem will enable a new generation of human interaction with synthetic environments, with unbounded commercial potential.

ARPA 94-089 TITLE: Prototype Implementations of Scalable High Performance Computing Software and Environments

CATEGORY: 6.2 Exploratory Development; Software

OBJECTIVE: The design and prototype demonstration of innovative software development tools and environments that will reduce the time and improve the quality of the implementation of high performance computing applications. These tools include, but are not limited to, language preprocessors, compilers, software library managers, code schedulers, code transformers, and debuggers.

DESCRIPTION: This effort encompasses research and development of innovative software development tools specifically supporting the development needs of high performance computing applications. These applications are characterized by a high degree of numerically-intensive computation, extensive use of library software packages, and considerable source and object level code optimization. New approaches for preprocessor, compilers, software library managers, code transformers, and debuggers that can operate in the presence of extensive code optimizations and run-time parallelism are needed. Methods for integrating such tools into a coherent, easy-to-use environment are also highly desirable. Supported source input languages should include those currently popular among the high performance computing applications development community, such as High Performance FORTRAN. Tools to be developed must be compatible with the operating systems, such as Mach, that are in widespread use within this community.

Phase I: In detail, define the candidate software development tools, system development architecture, technical approaches, interfaces, tradeoffs, and risks in comparison to existing approaches, along with supporting evidence of success, such as early feasibility analyses or prototyping experiments.

Phase II: Prototype, develop, demonstrate, evaluate and deliver software development tools and integrated design environments for high performance computing, along with associated documentation and evidence or performance evaluations that compare results to original predictions.

COMMERCIAL POTENTIAL: Lack of adequate software tools and environments has hampered the rapid development of applications that can fully exploit scalable computing. Innovative products could reduce the time for applications development and improve the quality of implementations. This provides a dual-use opportunity to dramatically improve the development process for computational-intensive DoD applications.

ARPA 94-090 TITLE: Computationally Efficient Parallel Codes, Algorithms, or Tools for Computational Prototyping

CATEGORY: 6.2 Exploratory Development; Design Automation

OBJECTIVE: Create or convert parallel codes, algorithms, or tools enabling the application of scalable parallel computing to various types of design processes.

DESCRIPTION: Research and development leading to design tools that leverage Scalable Parallel Computing technology being developed under the Federal High Performance Computing and Communication (HPCC) Program. Efforts may address any field of design for which significant leverage can be demonstrated; however, the area of electronic systems design, including computing systems and wireless systems, is of particular interest. Efforts of interest include parallel tools that enable or accelerate the prototyping of new processes, devices, modules, or systems. Efforts may either modify existing codes, algorithms, or tools, or create new ones, but in all cases proposals must clearly state what speed-ups are expected for what problem sets and what conditions.

Phase I: In detail, define the application, algorithm, the approach to parallelism, the limits of scalability, and quantify the expected benefits through simulation.

Phase II: Create the full parallel implementation of a tool that embodies the algorithm, and validate the performance on one or more actual design problems running on multiple nodes of an HPC system. Complete documentation of test cases and results must be delivered.

COMMERCIAL POTENTIAL: The development of computationally-efficient parallel design tools will expand the commercial markets for both CAD tools and scalable systems. Dramatic reduction in product time to market enabled by more accurate and rapid design simulation and verification will provide significant advantage to system developers. Scalable computing applied to computational prototyping will also shorten design cycles for dual-use systems by reducing the need for physical prototyping.

ARPA 94-091 TITLE: High Performance Data Compression and Bandwidth Management

CATEGORY: 6.2 Exploratory Development; Communications

OBJECTIVE: Demonstrate high performance compression methods and techniques for efficient use of bandwidth in applications of importance to DoD. High performance here implies achieving high compression ratios while retaining essential features of the data.

DESCRIPTION: DoD has increasing needs for methods which will enable efficient use of bandwidth in a large number of applications. At the same time, several new techniques are emerging, including wavelet-based methods, which offer the potential for efficient compression of data at high compression ratios while retaining essential features of the data. The goal of this solicitation is to exploit the most recent advances in compression algorithms and to demonstrate methods for efficient use of bandwidth in applications of interest to DoD. Applications of interest range from compression of image and video for transmission to sensor data from military platforms. A key feature of many of these is the requirement to process the data in real time. Solutions may involve algorithmic implementation on commercially available processors, or may involve chip development at later phases.

Phase I: Development and testing (in simulation) of algorithms for compression and bandwidth management. Proposals should include a description of proposed algorithm(s), how it is to be implemented, target application(s), and technical goals (in terms of compression ratios and measures of quality, for example).

Phase II: Enhancement and implementation of the methods in a realistic applications environment including hardware development, if required. A demonstration of real-time application of the techniques in an operational environment should be included.

COMMERCIAL POTENTIAL: General applications in communications, such as providing multimedia communications with substantially reduced bandwidth requirements and efficient transmission and storage of video and audio. There are also many specific applications requiring compression of data, such as acquisition and storage of seismic data for oil exploration. By reducing the amount of data to be transmitted by several orders of magnitude (with substantial loss of performance), one decreases the requirements for bandwidth for transmission and media for storage.

ARPA 94-092 TITLE: Application of High Temperature Superconducting Materials to Composite Structures in Thin-Film Interconnected Electronic Circuits

CATEGORY: 6.2 Exploratory Development; Materials and Processes

OBJECTIVE: Develop procedures for combining HTS thin-film technology with various active and passive components, to achieve greater integration and optimized performance in a single, cooled, package. Near-term applications of high temperature superconducting (HTS) materials will be in electronic modules incorporating integrated circuits (ICs), possibly with other discrete components, such as ferrite circulators and isolators, particularly for military hardware.

DESCRIPTION: In order to enhance the performance of complex circuitry involving ICs, the present trend in electronics integration is to depart from printed circuit boards to multi-chip modules (MCMs), where connections between ICs are much shorter to reduce signal latency. As part of the ARPA program in multi-chip integration, HTS interconnects are used for optimum performance and ease of manufacture, since they require much fewer layers to accomplish interconnections between ICs than do standard metal. Signal shape also is preserved because of the lack of dispersion in these materials. It is of interest to extend the degree of integration to include more than standard ICs (which are in the form of bare die on a substrate), possibly ferrite components and/or other technologies, to achieve as much as possible a complete system function. Since these components also can be derived from patterning films of various materials (including ferrites) on a substrate, a very compact multi-layer package (with multiple substrates) is a possibility.

Phase I: Phase I would require some operational definition of system function, a breakout into different thin-film and component technologies, a description of manufacturability and packaging issues, cooling, and a discussion of system optimization.

Phase II: Construct prototype devices demonstrating high temperature superconducting technology.

COMMERCIAL POTENTIAL: The electronics industry will benefit greatly from this program.

ARPA 94-093 TITLE: Remote, Miniature, Non-invasive Sensors of Body Chemistries and Vital Health Functions

CATEGORY: 6.2 Exploratory Development; Medical Information

OBJECTIVE: There is a need to instantly determine the health status of soldiers or individuals through the use of miniature, non-invasive, unobtrusive (embedded, portable, or wearable) sensors of vital body chemistries (blood, other vital fluids, or tissues) or vital functions (respiration, metabolism, etc.).

DESCRIPTION: Non-invasive sensors of health status are needed in three configurations: 1) wearable, by soldiers, law enforcement officers or individuals while in remote or hostile environments; 2) portable or hand held, by field medics, emergency rescue technicians or nurses to be taken to remote sites or within hospitals and nursing homes; and 3) embedded, within weapons, common appliances (such as toilets or telephones), or other objects, and electronically linked (direct or wireless) to a network. The sensors must be miniature, unencumbering, non-intrusive, robust and require no, or minimal action, from the user. It must have a query mode (the device can be "asked" for a result) and an alert mode (automatically alerts when a value outside of normal parameters is registered). The device must be capable of transmitting the data, either direct or wireless, to a display, portable/hand held computer, or network, data must be usable in a distributive, interactive collaborative information environment to rapidly assess individual health from the point of care or a central site.

Phase I: Develop a device may be designed to detect electrolytes, blood, metabolites, medications or other chemical parameters in vital fluids such as blood, saliva, urine, feces, expired air or by direct tissue measurement.

Phase II: Produce a ruggedized, miniaturized remote sensor system for field testing in the battlefield environment, and which has the potential for dual use/commercial applications. If such a potential exists, proposers are encouraged, on an optional basis, to obtain contingent commitment for private follow-on funding to pursue further development of the commercial product after the government funded research and development phases.

COMMERCIAL POTENTIAL: This program would offer profound benefits for Emergency Medical Treatment (EMT) offered by rescue personnel.

ARPA 94-094 TITLE: Test and Applications of Multi-Chip Modules

CATEGORY: 6.3 Advanced Development; Electronic Devices

OBJECTIVE: Develop novel approaches to simplify the test of advanced Multi-Chip Modules (MCM). Develop applications that leverage emerging MCM technologies, enabling new or improved products for computing, telecommunications, automotive, or aerospace applications.

DESCRIPTION: Multi-chip module technology offers the potential to interconnect dozens of "bare" silicon chips in a single package that may be no larger than the conventional package used for a single, complex integrated circuit. At the system level, MCM technology may lead to several potential benefits: 70% reduction in the volume and weight of the electronics, a doubling of the potential performance, and an increase in the reliability by an order of magnitude. While such a technology would have obvious payoffs in a variety of military systems, there is also an enormous potential in volume commercial markets such as computing, telecommunications, automotive, industrial and aerospace. To date, the use of MCM technology for high volume applications has been limited by cost, availability and perceived risks to large vertically integrated companies. The purpose of this topic is to identify new product areas that might benefit from this emerging technology and to explore its application.

There are at least two types of applications of particular interest: 1) Those where MCM technology can be transparently inserted into an existing system for a savings in size, weight, power or cost; 2) Those where MCM technology enables the creation of completely new or highly optimized products. In some cases, the former may be a precursor to the latter. For example, optimization of a product to take advantage of a 10-100x increase in usable chip I/O, drastic reductions in inter-chip propagation delays, and cleaner signal noise environments might mean repartitioning the functions of various ICs, redesigning off-chip drivers, modifying bus widths and protocols, reducing the supply voltage, and even modifying the system architecture. Examples of newly enabled components include a self-contained wireless local area network (LAN) or high-speed modem module, a high performance processor upgrade, and integrated sensor/control module, or a video processor. Due to their high operating speeds, incorporation of multiple technologies, varying design approaches and lack of accessibility to internal circuit nodes current MCMs are inherently difficult to test. Fundamentally new approaches are needed for both the design of chips and MCMs as well as for the testing of MCMs assembled out of chips obtained from multiple sources. These approaches should be able to detect defects in the bare die as well as accommodate mixes of circuit type (memory, logic, ASIC, linear) and design-for-test (DFT) strategies within the same MCM. Topics of interest include, but are not limited to, computer-aided test tools, die and substrate DFT tools, test equipment, built-in-self-test, bare die burn-in and test, MCM substrate test, and final module test.

Phase I: Define detail specifications for the proposed application or approach to test. For all MCM applications, specify the functions of all MCMs and anticipated implementation technologies. Compare the costs and functionality of the MCM-based approach with one based on conventional technologies. Perform a design analysis with detailed trade-off and cost data. Develop a plan to demonstrate the utility of the approach for volume production. For MCM test, develop a plan to demonstrate the utility of the approach in collaboration with an MCM design house, foundry or user. Conduct early proof-of-principle experiments to confirm the proposed approach. Prepare a business plan to ensure commercial availability of tools.

Phase II: Develop and demonstrate the complete prototype system defined in Phase I for applications, and compare costs, development times and performance with conventional technology implementations.

COMMERCIAL POTENTIAL: Multi-chip modules are a generic dual-use technology required by a broad range of both military and commercial electronic systems. MCMs are an attractive technology solution for nearly all commercial/military products that require high performance and high reliability. MCMs are particularly attractive for the next generations of wireless and hand-held electronic devices. Products (software, equipment, materials, processes) resulting from this effort would be sold/licensed to merchant manufacturers or users of MCMs.

ARPA 94-095 TITLE: Performance of Novel Techniques for Design of Asynchronous, Speed-Independent, Clock-Free Digital Circuits

CATEGORY: 6.2 Exploratory Development; Electronic Devices

OBJECTIVE: Quantify the advantages and disadvantages in speed, complexity, power consumption, and cost of asynchronous logic circuits in comparison to conventional digital logic circuits.

DESCRIPTION: Recently, fundamentally new methodologies for design of Boolean logic circuits have been proposed. Typical configurations substitute signal encoding schemes using two or more conductors per Boolean variable for conventional digital logic, which uses one conductor per variable. The new methodologies can be self-synchronizing, eliminating the requirement for an independent global clock signal as a synchronization mechanism among logic elements. Such self-synchronizing circuits potentially have several properties of interest to DoD. These include elimination of timing-based faults such as races and skew; speed-independent designs (to within device delay limits); greater suitability for high level synthesis; and greater fault tolerance. To date these new design methodologies have been investigated only analytically; no actual devices have been built. Consequently, the claimed advantages have not been tested, and a host of practical fabrication issues have not been addressed. These include design complexity, power consumption, device area, yield, reliability, and cost as compared to conventional circuit designs of similar functionality. This program is directed to the design, fabrication, and detailed evaluation with respect to conventional circuits of sample asynchronous logic circuits.

Phase I: Select two or more specific, non-trivial digital circuit functions as test cases. Examples include medium scale integration (MSI) components such as multiplexers, and large scale integration (LSI) components such as small microcontrollers. Using standard computer-aided design tools, develop detailed logic, circuit, and physical designs and the simulation results, estimate the area, power consumption, speed, and complexity of the asynchronous, designs and compare to standard commercial designs for the same function. Develop a comprehensive plan for design, fabrication, test, and evaluation of asynchronous digital circuits using standard process and packaging methodologies.

Phase II: Design and fabricate sample quantities of original two designs, plus one additional design of greater complexity, and compare to standard circuits for realizing the same function in the same process technology.

COMMERCIAL POTENTIAL: Because of their potential to provide a fundamentally new digital circuit technology with improved reliability, reduced complexity, and greater cost effectiveness, asynchronous digital circuits are candidates for inclusion into virtually all commercial electronics, including audio and video equipment, personal computers, telephone equipment, automotive controllers, medical equipment, and so forth.

ARPA 94-096 TITLE: Lock-In Acousto-Optic Time Correlator

CATEGORY: 6.1 Basic Research; Materials and Processes

OBJECTIVE: Design and build an acousto-optic based time signal correlator which can detect, extract, and lock in with a periodic time input signal having an unknown repetition rate.

DESCRIPTION: A lock-in time signal correlator is needed to process time-domain information from a new image-recognition system. The output of the system is a periodic signature signal that is object-specific yet invariant against most of the geometrical transformations of an optical image. While the periodic signature itself is invariant, its repetition rate is a function of the overall scene illumination. The signature amplitude is proportional to the image size, which can be only a few percent of the total scene size. Thus the lock-in time signal correlator must be able to adjust the repetition rate of the reference signature to match that of the input signal, and must be able to extract very low-amplitude signatures from a much stronger total time signal. The frequency range is estimated to be at least 1 MHz, with signature repetition rates from 1 to 100 kHz. The correlator system must include means of storing and adjusting the reference signature, and must be integrated with the overall image-recognition system that produces the invariant signatures.

Phase I: Perform analysis and design. Simulate the time correlator and determine the region of optimum performance. Fabricate a test bed system and measure its performance to determine its frequency capability and degree of discrimination at low signal amplitudes in clutter. Design a prototype system, fabricate, test, interface with image-recognition system, and evaluate its performance.

Phase II: Work will depend on the results of Phase I.

COMMERCIAL POTENTIAL: Electronic Industry, Image Processing Industry - This project involves improvements to image recognition processors and developing new and innovative techniques for processing, such that images are object-specific against geometrical transformations. This is needed in rapid identification of objects by automated means without use of prohibitively large memory elements. The image processing industry would develop and sell these units to manufacturing industries for use in automated factories.

ARPA 94-097 TITLE: Personal Computer Based, Tactical Missile Propulsion System, Hardware-in-the-Loop, Thrust Control Simulation/Analysis System

CATEGORY: 6.2 Exploratory Development; Software

OBJECTIVE: Develop a personal computer-based system that can be utilized to simulate and analyze the hardware-in-the-loop response of a thrust control system for a tactical missile propulsion system.

DESCRIPTION: The mission requirements of the next generation of tactical missiles will demand a level of propulsion system flexibility which will dictate the use of non-traditional propulsion systems such as monopropellant rockets, hybrid rockets, bi-propellant rockets, ducted rockets, air turbo ramjets (ATR), ramjets, and turbojets. To achieve the maximum level of flexibility from each of these respective propulsion cycles, a dedicated thrust control system is required. This system will receive throttle commands from the missile mission computer, acquire analog data from propulsion system sensors, and respond accordingly by sending the appropriate signal to the fuel metering device, which, as a result, will modulate the thrust. A means of quickly, economically, safely, but thoroughly evaluating and optimizing propulsion system thrust control is required. A personal computer-based thrust control simulation/analysis system is required that electronically interfaces with the thrust control system and provides a high fidelity, real-time dynamic simulation of the desired propulsion system. The simulation/analysis system must receive commands from the control system, and respond realistically in real-time with the corresponding simulated sensor outputs. The system shall also acquire appropriate control system data and provide an analysis of the control response. The system will be generic in nature, and reprogrammable to simulate a wide variety of engine cycles (including all those mentioned above). The software that is developed will utilize the Windows environment to the maximum extent. A graphical user interface is essential for rapid reconfiguration, and a library of general engine cycle simulations must be included.

Phase I: Develop and demonstrate a detailed design of the final thrust control simulation/analysis system and a preliminary simulation/analysis system for a single turbojet engine. At the completion of the demonstration, the simulation/analysis system, including all required computer hardware, software (including source code and commercial products), and electronic hardware shall be delivered to the Government for evaluation.

Phase II: Develop a complete thrust control simulation/analysis system including all required computer hardware and software and complete documentation. This system will incorporate an extensive library of engine cycle simulations.

COMMERCIAL POTENTIAL: Civilian Aerospace Industry - The modeling and simulation developed under this effort can be applied to civilian rocket engine development for commercial space applications in support of NASA and civilian independent vehicles.

ARPA 94-098 TITLE: Pulse-Coupled Neural Network for Automatic Target Recognition

CATEGORY: 6.1 Basic Research; Telecommunications

OBJECTIVE: Develop a reliable pulse-coupled neural network which can locate and recognize a given target in a 2 dimensional image plane of approximately 500 x 500 pixels.

DESCRIPTION: Automatic target recognition (ATR) techniques utilizing neural networks have been suggested in literature for many years. One of the theoretically most successful methods is the linking field pulse-coupled neural network model. It should be possible to construct such a neural network utilizing discrete and/or logic components. Such a device could be a major advancement to the ATR problem, both technically and economically.

Phase I: Design and build a prototype neural network capable of locating a target in a 2 dimensional image 256 x 256 pixels on a side supplied to the network via a CPU and a framegrabber. The network can be either optically or electrically addressed or some hybrid of the two.

Phase II: Refine the design to search a larger image plane of approximately 500 x 500 pixels on a side. Also, methods of training the neural network to locate a target while scale and rotation are changing should be demonstrated.

COMMERCIAL POTENTIAL: Manufacturing Industry - The successful development of a neural network processor that can recognize objects, identify them and locate them precisely is applicable to the automated manufacturing industry. This would allow machines to perform inspections of some operations. It could also be useful in surveillance systems for automatic determination of intruder identity (animals or humans, for instance).

ARPA 94-099 TITLE: Advanced Multimedia Imaging Helmets

CATEGORY: 6.2 Exploratory Development; Computers

OBJECTIVE: Develop and demonstrate advanced multimedia imaging helmets for coordination and collaboration of team members in a complex task and hostile environment.

DESCRIPTION: There is a need to design and demonstrate a family of modular, affordable, reconfigurable, and man-portable information-based systems that significantly enhances individual and overall team performance while planning and executing complex high risk tasks. Concepts for one or more variants of a family of advanced multimedia helmets are required. As an example, the range of possible applications include, but is not limited to, development of helmets for mobile shipboard operators (command, fire control, damage control, machinery control, etc.). These individuals must sense, process and display data locally while maintaining connectivity with other remote stations and operators and their distributed sensing, processing and display functionality. Other applications include special forces teams, police/FBI surveillance teams, fire-fighting teams and medical teams. As part of this effort, innovative concepts are sought for sensing, fusing and displaying multispectral imaging data with computer generated #D CAD, text, and auditory representations in a helmet-based system, while at the same time permitting the operator normal vision and auditory sensing. Characteristics include: Interactive planning and execution software for local expert access, and interactive information exchange for distributed team coordination and remote expert access.

Phase I: Provide a conceptual design for one or more variants of a family of advanced imaging helmets. Demonstrate selected high risk technologies and the extendibility of proposed concepts to related applications. Provide a performance, cost and development risk trade-off analysis with appropriate metrics.

Phase II: Design and demonstrate a full-scale prototype of one or more variants of the proposed family of imaging helmets. Conduct performance and cost sensitivity analysis to demonstrate concept viability.

COMMERCIAL POTENTIAL: This concept is applicable to any team planning or executing complex high risk tasks. Applications include police/FBI surveillance teams, fire-fighting teams, medical and paramedic teams.

ARPA 94-100 TITLE: The Development of a Sonic/Ultrasonic Ocean Spill Clean Up System

CATEGORY: 6.2 Exploratory Development; Materials and Processes

OBJECTIVE: Develop a system capable of separating non-miscible pollutants such as oil from sea water by sonic means.

DESCRIPTION: When two non-miscible liquids such (e.g., oil and water) are simultaneously subjected to ultrasonic radiation, an emulsion or colloid solution is formed. This is a result of the forces at the interface between the two liquids.

Phase I: Develop an initial plan and design of the clean up system concentrating on the laboratory selection of the appropriate frequency and source levels to emulsify oil and water.

Phase II: Design, construct and demonstrate a scaled prototypic ocean clean-up system specifying the application to larger scale clean-ups.

COMMERCIAL POTENTIAL: The potential for commercial use of this technology is extremely high for shipyards, off shore industry, and pollution control activities.

ARPA 94-101 TITLE: Process Technology for Low-Power Electronics

CATEGORY: 6.3 Advanced Development; Materials and Processes

OBJECTIVE: Develop and model aspects of advanced semiconductor process technologies for the fabrication of leading-edge integrated circuits (ICs) that consume markedly lower power than conventional Metal-Oxide-Semiconductor (MOS) technology, without sacrificing data rates or functionality.

DESCRIPTION: Device power dissipation is a significant limitation for a variety of electronic systems. This has been recognized by the semiconductor industry as a "showstopper" to device technology in the late 1990s. This SBIR solicitation will focus on the development of novel models and process technology for low power integrated circuits. Of particular interest

for this effort are the following:
(1) Advanced Modeling for Low Power Electronics. This task is focused on development of fundamental device models and circuit level design tools which provide power estimation and optimization. The device models should support fully depleted silicon on insulator structures with threshold voltages below 500 mV and provide an understanding of the device design and process tradeoffs. The circuit models will provide component power estimation and architecture tradeoffs. Each of these models must be computationally efficient and have an integration path to existing design tools.
(2) Shallow Junction Process Technology. This task is focused on the development of low thermal budget processes for shallow junction formation. As the minimum semiconductor feature size decreases, oxide thickness and source/drain junction depth are also reduced. The Semiconductor Industry Association has published roadmaps indicating that source/drain junction depths will decrease from 100nm in 1992, to 40nm by 1998, and to 10nm by 2004. These requirements will be accelerated for the fully depleted structures of interest. Development of novel approaches to form very shallow junctions is of interest.

Phase I: Perform detailed analysis of proposed approach to create shallow source/drain junctions or model low power electronics. Establish performance and cost metrics, identify major risk factors, develop customer and supplier relationships, and prepare business plan. Perform top-level design. As applicable, demonstrate feasibility of approach through risk reduction experiments or early prototypes.

Phase II: Complete detailed design and implement. As applicable, develop and prototype product in collaboration with suppliers and customers. Demonstrate performance against metrics defined in Phase I.

COMMERCIAL POTENTIAL: These technologies are generic, dual-use, and will be required by a broad range of military and commercial electronic systems. Developed products will be sold/licensed to merchant/captive semiconductor producers for a range of military/commercial applications.

ARPA 94-102 TITLE: Optoelectronic Components for Wavelength Division Multiplexed (WDM) Networks

CATEGORY: 6.3 Advanced Development; Electronic Devices

OBJECTIVE: Develop key optoelectronic components for communication and computer networks exploiting wavelength as a networking strategy. Example component technologies include multiwavelength lasers and laser arrays, wavelength selective filters and switches, and wavelength conversion devices.

DESCRIPTION: Optoelectronic components specifically designed for broadband communication systems are critical enablers for these applications. ARPA-sponsored research on All-Optical Networks has established the advantages of multiwavelength operation as one strategy for increasing network capacity and functionality. Research prototype components supporting this approach to broadband networks have been demonstrated. This solicitation seeks to extend these results to develop and demonstrate manufacturable components that can meet the requirements for deployable multiwavelength networks.

Phase I: Demonstrate prototype manufacturable components for multiwavelength network applications.

Phase II: Develop manufacturing techniques for the prototype components demonstrated in Phase I and demonstrate performance in one of the ARPA-sponsored All-Optical Network testbeds.

COMMERCIAL POTENTIAL: WDM technology is emerging as an effective strategy for broadband communications networks for both military and commercial use operating beyond OC-48, particularly in applications such as survivable SONET rings. Development of manufacturable components specifically designed for these applications should enhance the rate of deployment of these networks and stimulate the development of broadband network applications.

ARPA 94-103 TITLE: Small Lightweight Chemical Species or Warfare Agent Collection Devices

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Collect, detect, and monitor various chemical species for defense and commercial use. The Clean Air Act of 1990 places requirements on industrial facilities to reduce emissions. Municipalities express concern about the quality of the air and water in their localities.

DESCRIPTION: As a consequence of the Gulf War and the threat from unfriendly nations, the use of chemical agents on the battlefield is of continuing concern. Non-proliferation monitoring purposes require the means to monitor the production, testing and deployment of chemical agents. Counter proliferation purposes require the quick collection of chemical agents dispersed from attacks on suspected chemical warfare agent production facilities or chemical agent use by the enemy. Various technologies have been developed to detect and measure chemical agents. A few examples of these are surface acoustic wave devices, gas chromatography, and ion mobility spectrometry. One limiting consideration for use of these technologies is the means by which the chemical species are collected for measurement. Some means require air pumps to move air samples through columns for chemical concentration and subsequent analysis. Other means include passing air through filters. The species of interest are then removed from the filters by solvent extraction or thermal desorption. Still others use coatings on the sensors themselves as a collector. It takes minutes on site or hours in a laboratory to remove the chemical from the collector. None of these methods include water sampling. Each detection method requires a power source sometimes shared with the collector. This limits the lifetime of a compact device. To advance the capabilities of detection and measurement devices, collectors for air or water sampling should be developed for use in the battlefield, for monitoring outside suspected chemical agent production facilities, and general municipal use. Commercial potential is a consideration in the use of these collectors. The collector assembly should be lightweight (less than 5 pounds), compact (briefcase size and smaller), capable of use in air or water exclusively, use little power (generally less than 5 watts maximum), and have its own compact power supply for greater than 24 hour operation as a standalone system, if needed. Municipal and defense uses would include connection to a 110 volt outlet as an option. Collection time should be short to allow for analysis of chemical warfare agents in less than one minute. Commercial uses would have longer analysis times. The collector should be able to release the collected chemical species to the analysis equipment, as required. Integration into a system using one of the measurement technologies mentioned above or others should be considered.

Phase I: Provide innovative conceptual design of chemical agent collection device. Evaluate size, configuration, environmental effects on collector, selectivity, sensitivity and power requirements. Include technologies such as, but not limited to, gas chromatography, surface acoustic wave (SAW) devices, ion mobility spectrometry and others as analysis equipment for measuring the collected sample. Include possible commercial uses.

Phase II: Design, construct, and test a prototype collection device connected to analysis equipment.

COMMERCIAL POTENTIAL: This program will allow industrial facilities to monitor chemical emissions and adhere to the Clean Air Act.

ARPA 94-104 TITLE: Photonic Radar Systems

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop new concepts and approaches in integrated radar system technology utilizing photonic elements to achieve significantly greater system performance.

DESCRIPTION: Photonic technologies have the potential to allow much greater radar system performance that can otherwise be achieved with conventional digital or analog signal processing. As a result, systems architectures which exploit advancements in photonic technology to achieve significant radar performance improvements are being sought. The fully integrated system must be capable of detecting very small radar cross section targets, such as sea skimming and cruise missiles; providing high resolution range measurements; and reducing sensitivity to electronic countermeasures.

Phase I: Address concepts for and approaches to the development of photonic radar systems. Identify the most suitable approach, and perform sufficient analysis and design to indicate a reasonable probability of success in feasibility demonstration.

Phase II: Use the approach defined in Phase I to develop detailed system requirements, build and demonstrate selected critical system elements, and deliver a preliminary radar system technology demonstration design to the Government for evaluation.

COMMERCIAL POTENTIAL: Low cost, low weight radar; ubiquitous radar applications.

ARPA 94-105 TITLE: Improving Manufacturing Quality through the Use of Advanced Vision Techniques for Inspection and/or Mensuration

CATEGORY: 6.2 Exploratory Development; Software

OBJECTIVE: Detect flaws and out-of-tolerance conditions in manufactured objects by use of vision algorithms applied to images of the objects. Images can be obtained from X-ray, tomographic, range-imaging, or electro-optical cameras.

DESCRIPTION: Flaws and out-of-tolerance conditions in manufactured objects can be detected by non contact vision techniques using a variety of sensors. Novel vision techniques are sought that can be implemented in low-cost computers in a factory setting. Such devices should be readily adapted to different objects without requiring skilled programming. Examples of applications include detection of wire bond failures, defects in VLSI wafers and masks, dimensional analysis of cast parts, measurement of surface topography, and 3-D analysis of tomographic data to detect internal flaws in solid objects. (Such flaws can be voids, internal cracks, or non-uniformities that can lead to failure of the object.)

Phase I: Find a specific manufacturing application and apply the chosen technique to that problem.

Phase II: Using the application developed in Phase I, indicate the advantages and limitations of the approach and suggest other manufacturing problems to which the approach could be economically applied.

COMMERCIAL POTENTIAL: This effort is directly usable by the commercial world in the area of manufacturing. An inexpensive, reliable inspection/mensuration device will find many applications in flexible manufacturing.

ARPA 94-106 TITLE: Solid Modeling Systems to Support Automated Reasoning

CATEGORY: 6.2 Exploratory Development; Design Automation

OBJECTIVE: Develop, enhance and demonstrate a solid modeling system that will support automated reasoning capabilities.

DESCRIPTION: Current solid modeling systems are basically graphical and geometric representation tools that do not support the capability to reason about the geometry or tolerances or other parameters and features of interest for manufacturing and assembly. This is mainly due to the deficient data structures that are employed in representing information. The ability to reason, both qualitatively and quantitatively, about various attributes of a design is important for developing integrated design manufacturing systems. It is important to be able to represent a design and then easily transition between several different representations. It is also important to be able to develop qualitative and quantitative reasoning algorithms that work directly on the 3D Solid modeler description of a product. Quantitative reasoning, for example, would include, but not be limited to, the ability to determine the degrees-of-freedom of a system of multiple bodies in contact or the ability to reason about tolerancing. Research and development is required that will transition new innovations into the domain of commercial solid modeling systems.

Phase I: Define and develop several concepts for suitable data structures, evaluate the computational and representational advantages/disadvantages of the proposed data structures, and demonstrate the efficacy of the chosen data structure.

Phase II: Develop a complete system with an user interface and demonstrate it in the context of an assembly/manufacturing application.

COMMERCIAL POTENTIAL: The technology developed under this research and development effort will be critical for creating the capability to develop real-time executable code, for a flexible assembly cell or a machining workstation, automatically from a 3-D modeler description of the part or the product. This capability, in turn, will form the basis for the future reconfigurable factories and assembly cells that will be able to produce commercial and defense products economically.

UNITED STATES SPECIAL OPERATIONS COMMAND

Proposal Submission

The United States Special Operations Command's (USSOCOM) missions include developing and acquiring unique special operations forces (SOF) equipment, material, supplies and services. Desired SOF operational characteristics for systems, equipments and supplies include: lightweight and micro-sized; reduced signature and low observable; built-in survivability; modular, rugged, reliable, maintainable and simplistic; operable in extreme temperature environments; water depth and atmosphere pressure proof; transportable by aircraft, ship and submarine, and deployable by airdrop; LPI/LPD jam resistant C3I, electronic warfare capable of disruption and deception; near real-time surveillance, intelligence and mission planning; highly lethal and destructive; low energy/power requirements; and compatible with conventional force systems. USSOCOM is therefore seeking small businesses with a strong research and development capability and understanding of the necessity for consideration of these SOF operational characteristics for systems. The topics on the following pages represent an introduction to a portion of the problems encountered by the SOF in fulfilling its mission.

USSOCOM invites the small business community to send its proposals directly to the following address:

United States Special Operations Command
Attn: SOKS/SBIR Program, Topic No. SOCOM94-____
2408 Florida Keys Avenue
MacDill Air Force Base, Florida 33621-5316

The proposals will be processed, then distributed to the appropriate technical office for evaluation. Inquiries of a general nature or questions concerning the administration of the SBIR program and proposal preparation should be addressed to:

United States Special Operations Command
Attn: Ms. Paulette Widmann
2408 Florida Keys Avenue
MacDill Air Force Base, Florida 33621-5316
Telephone: (813) 840-5443

The USSOCOM has identified four technical topics for this, the second of two SBIR solicitations to be released during FY 1994 by DOD, to which small businesses may respond. The topics listed are the only topics for which proposals will be accepted. The topics were initiated by USSOCOM technical offices that manage the research and development in these areas. No direct communication with the topic author is possible. No additional technical information is available during the solicitation period. The only source for technical information is the Defense Technical Information Center (DTIC). Please refer to Section 7.1 in this solicitation for further information on DTIC.

Firms are encouraged to submit a proposal for an option task which would be performed during the period between Phase I completion and Phase II contract award. The optional task provides the opportunity to reduce the gap between Phase I and II. The maximum amount of SBIR funding used for any USSOCOM phase I award is $100,000. Proposals that include the option task shall not exceed $70,000 for Phase I and $30,000 for Phase I Option. Any option proposal must be submitted at the same time and place as the basic Phase I proposal and not be included in the basic Phase I proposal page limitation. The basic Phase I proposal shall be evaluated exclusive of the option task and must be proposed and priced separately. The option portion of the proposal shall not exceed 10 pages, not exceed $30,000, not exceed three months in duration, and be evaluated using the same evaluation criteria as Phase I proposals. The transition option work shall be included as an option in the Phase I contract and evaluated for USSOCOM unilateral exercise at any time after Phase I award through the conclusion of the basic Phase I contract. Exercise of any option shall be at the sole discretion of USSOCOM and shall not obligate USSOCOM to make a Phase II award.

Selection of proposals for funding is based upon technical merit and the evaluation criteria included in this solicitation. As funding is limited, USSOCOM reserves the right to select and fund only those proposals considered to be superior in overall technical quality and most critical. As a result, USSOCOM may fund more than one proposal in a specific topic area if the technical quality of the proposals is deemed superior, or it may fund no proposals in a topic area.

US SPECIAL OPERATIONS COMMAND
FY 94.2 SBIR TOPIC INDEX

MATERIALS

SOCOM 94-005 Adhesives

LASER, OPTICS AND POWER SYSTEMS

SOCOM 94-006 Wavelength Independent Human Laser Eye Protection

SOCOM 94-007 Fiber Optic Cable Communications Adapter for Tactical Radios

SURVIVABILITY AND HARDENING

SOCOM 94-008 Engine Infra-red (IR) Signature Suppression

SUBJECT/WORD INDEX TO THE U.S. SOCOM TOPICS

U.S. SOCOM FY94.2 TOPICS

SOCOM 94-005 TITLE: Adhesives

CATEGORY: Exploratory Development; Materials

OBJECTIVES: Develop family of adhesives to bond similar and dissimilar materials for repair and construction.

DESCRIPTION: A multi-approach program to explore the use of adhesives for quick attachment of sensors, munitions, and other equipment onto unprepared surfaces in less than ideal environments. The surfaces may be stationary or moving, above or below fresh, salt, and brackish water, overhead horizontal or vertical plane structures, and exposed to environmental elements (e.g. fouled ship hulls, fouled mines, and barnacle covered surfaces). The bonding/adhesive materials will also be used for field expedient repairs of wood and wood products, metal, composites, plastics, and fabrics. The family of adhesives will also be used for general construction.

Phase I: Identify products and methods for developing quick curing/setting adhesives that bond dissimilar materials onto unprepared surfaces when underwater and in less than ideal environmental conditions.

Phase II: Develop durable, easily applied, low volume adhesives that can be used for:

a. Expedient and reliable repairs of the outer skins of rotary/fixed winged aircraft, hulls and engines of boats/ ground vehicles, and other equipment when deployed in hostile environments without logistic support.

b. Bonding of dissimilar materials, e.g., materials used in office buildings, housing, load bearing and bridging type construction, wood products, metal, composites, plastics, and fabrics.

COMMERCIAL POTENTIAL: The potential for use of improved adhesives throughout industry and military is limitless. Adhesives having better properties than existing materials will have markets in the construction, aerospace, automotive and electronics industries. Adhesives which could be used to repair machinery or equipment without taking the system off-line would have high utility.

SOCOM 94-006 TITLE: Wavelength Independent Human Laser Eye Protection

CATEGORY: Exploratory Development; Laser, Optics and Power Systems

OBJECTIVES: Enhance the capability to protect human eyes from lasers operating at any wavelength.

DESCRIPTION: USSOCOM is interested in enhanced capabilities to protect human eyes from lasers operating at unknown wavelengths and in the spectral region from 400-900nm. Candidate concept shall be evaluated for laser attenuation, impact on operator (pilot and ground crews), cockpit and equipment compatibility, and environmental durability. Selected technologies shall be implemented into laser protective devices capable of providing protection from damage and transient effects when irradiated by a laser. Potential concepts to be explored include, tunable filters, liquid limiters, sacrificial filters, and optical switches.

Phase I: During this phase the offeror will demonstrate the feasibility of an exploratory concept (preferably advanced from holographic and dye technology) and identify the material design and technology needs that must be matured for a protection device(s) demonstration.

Phase II: Optimize, fabricate, and demonstrate feasibility of phase I eye protection device design concept. Testing will include optical performance, laser rejection efficiency, and environmental stability. Also, these devices will be examined for compatibility with the operator's equipment, and cockpit lighting, operator performance impact, and acceptability.

COMMERCIAL POTENTIAL: This technology will have many applications in all electronic and engineering fields that pertain to lasers. This application will provide needed safety devices for worker protection.

SOCOM 94-007 TITLE: <u>Fiber Optic Cable Communications Adapter for Tactical Radios</u>

CATEGORY: Engineering Development; Lasers, Optics and Power Systems.

OBJECTIVE: To design, develop, and field test a fiber optic cable communications adapter for standard US tactical VHF radios.

DESCRIPTION: Design, develop, and field test a small, lightweight (four pounds or less, minus cable and cable reel), diode laser powered fiber optic cable communications transceiver that attaches to the radio frequency (RF) antenna connector of standard US VHF tactical radios. The laser transmitter is modulated by the RF energy of the tactical radio. Additional required power is obtained from the radio battery. The adapter is attached between the radio antenna connection and to a 5 kilometer reel of monofilament optical cable to provide secure point-to-point tactical communications during military operations requiring stealth and security.

Phase I: Develop and fabricate one prototype for lab testing.

Phase II: Based upon lab test results, refine design, and test under tactical field conditions. Provide estimated production costs for 25 and 100 units.

COMMERCIAL POTENTIAL: Adapters for commercial radios and walki-talki radios for use in areas of high co-channel interference, EMI, or in areas where RF communications are prohibited.

SOCOM 94-008 TITLE: <u>Engine Infra-red (IR) Signature Suppression</u>

CATEGORY: Exploratory Development; Survivability and Hardening

OBJECTIVES: Develop a light weight, low drag engine IR suppression for SOF aircraft.

DESCRIPTION: Primary emphasis is the proposed system must be light weight and low drag. SOF aircraft are very large, slow moving and can not accept more weight and drag unless balanced weight reductions are made. A need exists to suppress the non-visual signature of SOF aircraft in the IR frequencies. The aircraft engines on the C-130, H-47s, H-53s, H-60s, and M-VX need exploratory IR suppression techniques.

Phase I: During this phase the offeror will analyze the specific design restrictions and expand on their suppression concept showing specifically the low weight and drag elements for SOF C-130 aircraft with the goal to include other aircraft.

Phase II: Optimize and develop a low cost working prototype that demonstrates the Phase I concept.

COMMERCIAL POTENTIAL: Commercial airline industry would use this technology if it is low cost.

APPENDIX A

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROPOSAL COVER SHEET

Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ______________________

PROPOSAL TITLE: ______________________

____

FIRM NAME: ______________________

MAIL ADDRESS: ______________________

____

CITY: ______________________ STATE: ________ ZIP: ________

PROPOSED COST: ______________ PHASE I OR II PROPOSAL ______ PROPOSED DURATION IN MONTHS ______

BUSINESS CERTIFICATION:

	YES	NO
▶ Are you a small business as described in paragraph 2.2?	☐	☐
▶ Are you a minority or small disadvantaged business as defined in paragraph 2 3? (Collected for statistical purposes only)	☐	☐
▶ Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	☐	☐
▶ Has this proposal been submitted to other US government agency/agencies, or DoD components, or other SBIR Activity? If yes, list the name(s) of the agency, DoD component or other SBIR office in the spaces to the left below If it has been submitted to another SBIR activity list the Topic Numbers in the spaces to the right below	☐	☐

______________________ ______________________

______________________ ______________________

▶ Number of employees including all affiliates (average for preceding 12 months) ______________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ______________	NAME: ______________
TITLE: ______________	TITLE: ______________
TELEPHONE: ______________	TELEPHONE: ______________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: ______________________

SIGNATURE OF PRINCIPAL INVESTIGATOR	DATE	SIGNATURE OF CORPORATE BUSINESS OFFICIAL	DATE

Nothing on this page is classified or proprietary information/data.

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following typestyles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and SUBMIT THE ORIGINAL RED FORMS bound in this solicitation (not photocopies) as page 1 and 2 of the original copy of each proposal. The completed forms can then be copied for use as pages 1 and 2 of the photocopies of the proposal. The original proposal (with red forms) plus (4) complete copies must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional red forms may be obtained from your State SBIR Organization (Reference D) or:

Defense Technical Information Center
ATTN: DTIC-SBIR
Building 5, Cameron Station
Alexandria, VA 22304-6145
(800) 225-3842 (Toll Free)
(703) 274-6902 (Commercial)

APPENDIX B

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

Failure to use a RED Copy as the original for each proposal and to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ______________________

PROPOSAL TITLE: ______________________

____

FIRM NAME: ______________________

PHASE I or II PROPOSAL: ________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development

List a maximum of 8 Key Words that describe the Project.

______________________ ______________________

______________________ ______________________

______________________ ______________________

______________________ ______________________

Nothing on this page is classified or proprietary information/data

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APPENDIX A

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROPOSAL COVER SHEET

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TOPIC NUMBER: ______________________

PROPOSAL TITLE: ______________________

____

FIRM NAME: ______________________

MAIL ADDRESS: ______________________

____

CITY: ______________ STATE: ________ ZIP: ________

PROPOSED COST: ______________ PHASE I OR II PROPOSAL ______ PROPOSED DURATION IN MONTHS: ______

BUSINESS CERTIFICATION.

	YES	NO
▶ Are you a small business as described in paragraph 2.2?	☐	☐
▶ Are you a minority or small disadvantaged business as defined in paragraph 2.3? (Collected for statistical purposes only)	☐	☐
▶ Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	☐	☐
▶ Has this proposal been submitted to other US government agency/agencies, or DoD components, or other SBIR Activity? If yes, list the name(s) of the agency, DoD component or other SBIR office in the spaces to the left below. If it has been submitted to another SBIR activity list the Topic Numbers in the spaces to the right below	☐	☐

______________________ ______________________

______________________ ______________________

▶ Number of employees including all affiliates (average for preceding 12 months) ______________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME:	NAME:
TITLE:	TITLE:
TELEPHONE:	TELEPHONE:

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PROPRIETARY INFORMATION: ______________________

SIGNATURE OF PRINCIPAL INVESTIGATOR ______ DATE ______ SIGNATURE OF CORPORATE BUSINESS OFFICIAL ______ DATE

Nothing on this page is classified or proprietary information/data.

APPENDIX B

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

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TOPIC NUMBER: ____________________

PROPOSAL TITLE: ____________________

____

FIRM NAME: ____________________

PHASE I or II PROPOSAL: ________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development

List a maximum of 8 Key Words that describe the Project.

____________	____________
____________	____________
____________	____________
____________	____________

Nothing on this page is classified or proprietary information/data

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
COST PROPOSAL

Background:

The following items, as appropriate, should be included in proposals responsive to the DoD Solicitation Brochure.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Topic number and topic title from DoD Solicitation Brochure
6. Total dollar amount of the proposal
7. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost dollars)
   d. Total direct material (dollars)
8. Material overhead (rate_____%) x total direct material = dollars
9. Direct labor (specify)
   a. Type of labor, estimated hours, rate per hour and dollar cost for each type
   b. Total estimated direct labor (dollars)
10. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost
    b. Total estimated labor overhead (dollars)
11. Special testing (include field work at government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
12. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
13. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
14. Consultants
    a. Identify each, with purpose, and dollar rates
    b. Total estimated consultants costs (dollars)
15. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
16. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
17. Royalties (specify)
    a. Estimated cost (dollars)
18. Fee or profit (dollars
19. Total estimate cost and fee or profit (dollars)
20. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
21. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
22. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

TO: ____
Fill in firm's name and mailing address

SUBJECT: SBIR Solicitation No. 94.2
Topic No. ____________
Fill in Topic No.

This is to notify you that your proposal in response to the subject solicitation and topic number has been received by

____
Fill in name of organization to which you will send your proposal.

______________________ ____________
Signature by receiving organization Date

To: SBIR Participants

SMALL BUSINESS INNOVATION RESEARCH PROGRAM REQUEST FOR DTIC SERVICES

For assistance in the preparation of informed proposals addressing the topics presented in the DoD SBIR Program Solicitation, you are encouraged to request annotated bibliographies of technical reports from the Defense Technical Information Center (DTIC). The cited reports cover selected prior DoD-funded work in related areas. Reasonable numbers of these reports may be obtained at no cost from DTIC under the SBIR Program. You will also receive information on related work-in-progress, and references to other information resources.

Complete the request form, fold, stamp and mail. Please bear in mind that significant mailing delays can occur, please order early.

DTIC authorization to provide this service expires July 15, 1994, the DoD SBIR Program Solicitation No. 94.2 closing date.

REQUESTER____
Name

ORGANIZATION NAME______________________________________

ADDRESS____
Street

______________________________________ PHONE______________
City State Zip Code Area Code/Number

Send technical reports bibliographies on the following SBIR topics:

TOPIC NUMBER	TOPIC NUMBER		TOPIC NUMBER	TOPIC NUMBER
1______	6______		11______	16______
2______	7______	*PLEASE TYPE OR PRINT IN THE ORDER TOPICS APPEAR IN THE SOLICITATION*	12______	17______
3______	8______		13______	18______
4______	9______		14______	19______
5______	10______		15______	20______

Company Status: I confirm that the business identified above meets the SBIR qualification criteria presented in Section 2.2 of the DoD Program Solicitation.

This is our first request during the current solicitation: yes____no____.

____
Signature of Requester

========================FOLD HERE========================

STAMP

Return Address

Defense Technical Information Center
Building 5, ATTN: SBIR
Cameron Station
Alexandria, VA 22304-6145

========================FOLD HERE========================

Associate Directors of Small Business assigned at Defense Contract Management Districts (DCMD) and Defense Contract Management Area Operations (DCMAO):

DCMD WEST
ATTN: Renee Deavens
222 N. Sepulveda Blvd., Suite 1107
El Segundo, CA 90245-4394
(800) 233-6521 (Toll Free CA Only)
(800) 624-7372 (Toll Free-AK,HI,ID,MT,NV,OR,WA)
(310) 335-3260
(310) 335-4443 (FAX)

DCMAO San Francisco
ATTN: Robert Lane
1265 Borregas Ave.
Sunnyvale, CA 94089
(408) 541-7041/7042

DCMAO San Diego
ATTN: Marvie Bowlin
7675 Dagget Street, Suite 200
San Diego, CA 92111-2241
(619) 495-7459/7467

DCMAO El Segundo
ATTN: Debbie Tatum
222 N. Sepulveda Boulevard, Suite 404
El Segundo, CA 90245-4320
(310) 335-3511/3495

DCMAO Seattle
ATTN: Alice Toms
Corporate Campus, East 111
3009 112th Ave., NE, Suite 200
Bellvue, WA 98004-8019
(200) 889-7317/7318

DCMAO Santa Ana
ATTN: Laura Robello
34 Civic Center Plaza, PO Box C-12700
Santa Ana, CA 92712-2700
(714) 836-2913 (ext. 659 or 661)

DCMAO Van Nuys
ATTN: Diane Thompson
6230 Van Nuys Boulevard
Van Nuys, CA 91401-2713
(818) 904-6158

DCMAO St. Louis
ATTN: William Wilkins
1222 Spruce Street
St. Louis, MO 63103-2811
(314) 331-5392 (ext. 231 or 229)

DCMAO Phoenix
ATTN: Clarence Fouse
The Monroe School Building
215 N. 7th Street
Phoenix, AZ 85034-1012
(602) 379-6177

DCMAO Chicago
ATTN: Norma Thorpe
O'Hare International Airport
10601 W. Higgins Road, PO Box 66911
Chicago, IL 60666-0911
(312) 825-6021

DCMAO Denver
ATTN: Robert Sever
Orchard Place 2, Suite 200
5975 Greenwood Plaza Blvd.
Englewood, CO 80110-4715
(303) 843-4381

DCMAO Milwaukee
ATTN: Paul Roppuld
Henry S. Ruess Federal Plaza
310 West Wisconsin Avenue
Milwaukee, WI 53203-2216
(414) 297-4339

DCMAO Twin Cities
ATTN: Otto Murry
3001 Metro Drive, Suite 200
Bloominton, MN 55425-1911
(612) 335-2003

DCMAO Wichita
ATTN: George Luckman
U.S. Courthouse Suite D-34
401 N. Market Street
Wichita, KS 67202-2095
(316) 269-7137

DCMD MID-ATLANTIC
ATTN: Jan D. Mirijanian
2800 S. 20th Street
Philadelphia, PA 19101-7478
(800) 258-9503
(215) 737-4006
(215) 737-8131 (FAX)

DCMAO Baltimore
ATTN: Gregory Prouty
200 Towsontown Boulevard West
Towson, MD 21204-5299
(410) 339-4809

DCMAO Cleveland
ATTN: Herman Peaks
1240 East 9th Street
Cleveland, OH 44199-2064
(216) 522-5446

DCMAO Dayton
ATTN: Betty Adams
c/o Defense Electronics Supply Center
Building 1, 1507 Wilmington Pike
Dayton, OH 45444-5300
(513) 296-5150

DCMAO Detroit
ATTN: David Boyd
905 McNamara Federal Bldg, 477 Michigan Ave.
Detroit, MI 48226-2506
(313) 226-5180

DCMAO Philadelphia
ATTN: Julia Graciano
2800 S. 20th Street, PO Box 7699
Philadelphia, PA 19101-7478
(215) 737-5818

DCMAO Pittsburg
ATTN: Fred Fundy
1000 Liberty Avenue
Pittsburgh, PA 15222-4190
(412) 644-5926

DCMAO Reading
ATTN: Thomas Knudsen
45 South Front Street
Reading, PA 19602-1094
(215) 320-5012

DCMAO Springfield
ATTN: Sylvia Liggins
955 South Springfield Ave.
Springfield, NJ 07081-3170
(201) 564-8204

DCMD NORTHEAST
ATTN: John McDonough
495 Summer Street, 8th Floor
Boston, MA 02210-2184
(800) 348-1011 (Toll Free MA Only)
(800) 321-1861 (Toll Free Outside MA)
(617) 451-4317/4318
(617) 451-3174 (FAX)

DCMAO Boston
ATTN: Gerald Hyde
495 Summer Street
Boston, MA 02210-2184
(617) 451-4108/4109/4110

DCMAO Bridgeport
ATTN: Otis Wade
555 Lordship Boulevard
Stratford, CT 06497-7124
(203) 385-4412

DCMAO Garden City
ATTN: John Richards
605 Stewart Avenue
Garden City, NY 11530-4761
(516) 228-5724

DCMAO Hartford
ATTN: Frank Prater
130 Darlin Street
E. Hartford, CT 06108-3234
(203) 291-7706/7705

DCMAO New York
ATTN: John Castellane
201 Varick Street, Room 1061
New York, NY 10014-4811
(212) 807-3050/3052

DCMAO Syracuse
ATTN: Ralph Vinciguerra
615 Erie Boulevard, West
Syracuse, NY 13204-2408
(315) 423-5664

DCMAO Grand Rapids
ATTN: Kay Hamilton
678 Front Street, NW
Grand Rapids, MI 49504-5352
(616) 456-2620

DCMAO Indianapolis
ATTN: Robert Staton
Building 1
Fort Benjamin Harrison, IN 46249-5701
(317) 542-2015

DCMD SOUTH
ATTN: Howard Head, Jr.
805 Walker Street
Marietta, GA 30060-2789
(800) 551-7801 (Toll Free-GA)
(800) 331-6415 (Nationwide)
(404) 590-6196
(404) 590-2612 (FAX)

DCMAO Atlanta
ATTN: Evelyn Taylor
805 Walker Street
Marietta, GA 30060-2789
(404) 590-6197

DCMAO Birmingham
ATTN: Lola Alexander
2121 Eight Avenue, N., Suite 104
Birmingham, AL 35203-2376
(205) 226-4304

DCMAO Dallas
ATTN: Jerome Anderson
1200 Main Street, Room 640
PO Box 50500
Dallas, TX 75202-4399
(214) 670-9205

DCMAO Orlando
ATTN: Russell Nielson
3555 Maguire Boulevard
Orlando, FL 32803-3726
(407) 228-5113/5260

DCMAO San Antonio
ATTN: Thomas Bauml
615 E. Houston Street, PO Box 1040
San Antonio, TX 78294-1040
(512) 229-4650

DCDM INTERNATIONAL
DCMAO Puerto Rico
ATTN: Victor Irizarry
209 Chapel Drive
Navy Security Group Activity
Sabana Seca, PR 00952
(809) 795-3202

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE	5. FUNDING NUMBERS
6. AUTHOR(S)	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT	12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

14. SUBJECT TERMS	15. NUMBER OF PAGES
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to *stay within the lines* to meet *optical scanning requirements*.

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Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C	- Contract	PR	- Project
G	- Grant	TA	- Task
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Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

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Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

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Standard Form 298 Back (Rev. 2-89)

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